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UTILIZATION OF DISCOUNT COTTONS IN MAJOR END USES

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FOREWORD

This comprehensive research program to develop improved textile blending and processing techniques for discount cotton involves cooperation from many parties. The Southern Marketing and Nutrition Research Division (SMNRD) expresses appreciation to the textile industry for furnishing technical information on processing organizations, commercially finishing many of the fabrics, and making marketability evaluations, especially to M. Lowenstein and Sons, Inc. (sheeting), Spring Mills (printcloth), Graniteville Co. (denim), and J. P. Stevens and Co., Inc. (twill). The Division also thanks W. J. Martin, Extension Service, USDA, for assisting with the cooperative arrangements, Herschel W. Little, SMNRD, for planning the experimental design and directing analyses of the data, and the Cotton Properties Laboratory, SMNRD, for the extensive measurements of fiber, yarn, and fabric properties.

The Division is grateful to the Textile Research Center, Texas Tech University, Lubbock, Texas for planning and executing the excellent research on short staple cotton, and to the Plains Cotton Growers Association for their diligent efforts in locating and furnishing the cottons.

The research program was conceived by, and conducted under the direct supervision of, R. A. Rusca, Chief, Cotton Mechanical Laboratory, SMNRD.

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UTILIZATION OF DISCOUNT COTTONS IN MAJOR END USES

prepared by

Southern Marketing and Nutrition Research Division
Agricultural Research Service

PREFACE

Several years ago there was much concern in industry and government about the surplus of extra-low and extra-high Micronaire cotton and of short staple cotton. These are the so-called discount cottons, averaging about 24 percent of the crop, that are customarily sold at discounts ranging up to 5 cents per pound below the price of basis cotton (1-inch, Middling grade, 3.5 to 4.9 Micronaire).

The U. S. Department of Agriculture's Southern Marketing and Nutrition Research Division in New Orleans, La. initiated a comprehensive research program to develop improved textile blending and processing techniques that would enable producing commercial quality fabrics from discount cotton. The research on medium-staple cotton was conducted by the Division's Cotton Mechanical Laboratory, and on short-staple cotton by the Textile Research Center, Texas Tech University, Lubbock, Texas, under USDA contract.

Three years after the program was started in 1968, the work was completed. In the interim, the substantial surplus of discount cotton in the government loan and private stocks has largely disappeared because of short crop years and changing technology. This situation may well be temporary, as environmental conditions and the ever-changing cycle of textile requirements could again result in surpluses of discount cottons.

The development of processing and finishing techniques that will allow low and high Micronaire cotton to be used in mill mixes in large proportions for a wide range of fabrics will result in a stable market for these cottons. Consequently, problems of surplus will be less apt to occur. Increased demand for discount cotton inevitably will be reflected in higher prices to the farmer, while the textile mills would still benefit from somewhat lower prices for their raw material. This adjustment in prices as a result of increased demand has already become evident.

The compendium of articles presented in this publication describes the results of research on medium and short staple cottons. It is believed that the findings will be of interest to the cotton industry.

C. H. Fisher, Director
SMNRD, ARS, USDA

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UTILIZATION OF MEDIUM STAPLE DISCOUNT COTTON IN SHEETING FABRICS

by

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The textile industry has long used low and high Micronaire Reading cottons in mixes with average Micronaire Reading cottons, but this usage is normally restricted to small percentages of about 3.2 to 5.0 Micronaire cottons. Research (2, 3, 4, 6, 7, 9, 10) has stimulated the use of offrange Micronaire Readings cottons. Problems of processing and quality, however, are reported when these cottons are included in mixes for fabrics, such as sheetings, printcloth, and the heavier denims and twills.

The Southern Marketing and Nutrition Research Division recently completed an investigation on the effects of blending medium staple cottons differing widely in Micronaire Reading on processing efficiency, yarn and fabric properties, and commercial marketability. The findings provide guidance to mills for the more efficient use of discount cottons.

This paper presents studies on sheeting. Three other papers that follow present studies on denim, printcloth, and twill, respectively. The processing organizations and yarn numbers used were specifically selected for each type of fabric produced and approximated processing conditions used in the cooperating mills. Marketing evaluations were made by a panel of experts from each mill and were based on visual examinations.

EXPERIMENTAL METHOD

Nineteen bales of an uknown variety cotton of about 1-1/16 inch classer's length and having Micronaire Readings ranging from 2.8 to 5.5 were used. These cottons were grouped into five levels of Micronaire Readings with fiber properties as shown in table 1.

The cottons were mixed in various percentages and made into eight experimental lots (mixes) of constant average Micronaire Reading (table 2).

These eight lots and a natural "control" cotton of about 4.4 Micronaire Reading were common to the sheeting, denim, and printcloth fabrics produced. Lots 3, 4, 6, and the control were used for the twill fabric.

Fiber, yarn, and fabric property measurements were determined by American Society for Testing and Materials methods (1). Fiber length measurements were made on the Digital Fibrograph while fiber bundle strength and elongation were made on the Stelometer.

Table 1. — Fiber properties of experimental cottons

Number of bales	Micronaire Reading	Fiber maturity	Grade	Fiber length: 2.5 percent span length	Fiber length: 50 percent span length	Fiber length: UR	Tenacity (1/8 inch -g.)	Elongation
		Percent		Inches	Inches	Percent	Gf/tex	Percent
2	2.8	48	SLM	0.99	0.38	38	22.8	9.0
2	3.1	55	SLM	1.04	0.42	40	22.0	9.5
7	4.4	75	M	1.04	0.47	45	21.8	6.6
4	5.1	84	SLM	1.06	0.49	46	21.7	7.4
4	5.5	88	SLM	1.03	0.48	46	22.4	6.4

[1/] One of the laboratories of the Southern Marketing and Nutrition Research Division, Agricultural Research Service, U. S. Department of Agriculture.

Table 2. — Micronaire Reading mix ratios and savings

Lots	Micronaire Reading 2.8	3.1	4.4	5.1	5.5	Average	Probable savings [1]
			Percent				$/500 lb.
C	—	—	100	—	—	4.4	0
1	—	10	70	20	—	4.3	1.59
2	10	—	70	—	20	4.3	2.95
3	—	20	30	50	—	4.3	3.54
4	—	30	—	70	—	4.3	5.12
5	25	—	—	75	—	4.2	6.19
6	20	—	30	—	50	4.3	6.69
7	—	35	—	—	65	4.3	8.10
8	30	—	—	—	70	4.3	9.64

[1] Based on 12-market cotton price averages for the month of November 1970.

The cottons were carded on a metallic wire card with a Crosrol-Varga attachment. End breakage data were obtained by the SRRL 720 Spindle Hour Test Method (2). Total spindle hours required for any given fabric depended on the amount of yarn needed for the warp and filling of the fabric.

Duncan's multiple-range test technique (8, pp. 107-109) was applied to measure the statistical significance of differences between means of processing, yarn, and fabric data. Some caution should be exercised in interpreting the significance of the differences shown in the graphs presented. Since a test for given property was not repeated on other samples from a given lot, variability used as a basis for significance of differences between lot averages was variability within tests. No measure of variability among tests for each lot is included, and the differences between means required for significance may be underestimated if lot means are to be construed as representing a considerable length of yarn or fabric. In other words, some of the differences shown as being statistically significant might not actually be significant if both variability among and within lots could have been included. However, it is not always practical to provide data for within lot comparison because of the nature of the experiment, such as in the case of end breakage in spinning.

Many of the differences shown in these reports were not deemed significant (were acceptable), and it is probable that these differences are actually not statistically significant.

The control lot was designated as Lot C, while all other lots were referred to by their number designations as shown in table 2: the higher the lot number, the lower the raw stock costs. The probable savings in rawstock of the experimental lots as compared with the cost of the control lot ranged from $1.59 to $9.64 per 500 pounds of cotton used. Average values obtained from the experimental lots that were similar to and not statistically different from the control lot were considered "acceptable" and are represented by solid bars in the graphs. All values that were superior to the control lots (though statistically different) were also considered "acceptable." Conversely, all values that were inferior and statistically different from the control were considered "not acceptable" and are represented by unshaded

bars. The control lot is represented by a shaded bar. Exceptions were made with end breakage and yarn variability data where predetermined levels were used as standards. These rules for the shades of bars were not applicable to graphs on which data were not statistically analyzed.

PROCESSING PROCEDURE

The mechanical processing organization and sheeting fabric specifications are shown in table 3.

The gray fabrics were commercially finished by the cooperating mill as follows:

1. Singed
2. Desized
3. Washed
4. Caustic boiled
5. Washed
6. Peroxide bleached
7. Washed
8. Starched and frame-dried

RESULTS

As previously stated, the results are presented by bar charts which enable direct comparisons among the various lots.

Waste

Figure 1 shows the processing waste of the control and experimental lots. Only lot 7 had as much card waste as lot C. The total picker and card wastes of Lots 1 and 3 were slightly higher than lot C, while all other lots were lower. Apparently the picking and carding processes did not preferentially remove fibers in mixes with extremes in Micronaire Reading.

Neps

Figure 2 compares card web neps of the control and experimental lots. All the experimental lots had more neps than Lot C. However, the differences noted were not considered of practical significance, because they were not reflected in the yarn grades.

End Breakage

Figure 3 shows the end breakage rate during spinning of the control and experimental lots. No trends were evident with either the warp or filling yarns. Some experimental lots had more and some had less

Table 3. — Mechanical processing variables and fabric specifications

Picker lap wt. (oz./yd.)	16.0	
Carding:		
Production rate (lb./hr.)	29.25	
Sliver wt. (gr./yd.)	60.0	
Drawing:		
Delivery speed (ft./min.)	800	
Doubling (1st & 2d drawing)	10	
Sliver wt. (1st & 2d drawing)	60.0	
Roving size (hank)	0.60	
Spinning:	Warp	Filling
Yarn number	21/1	23/1
Twist multiplier	4.34	3.63
Spindle speed (r.p.m.)	12,500	11,500
Ring diameter (in.)	2-1/4	2-1/4
Traveler number	1	1
Draft:		
Back	1.64	1.64
Total	35.0	38.4

Fabric specifications (Type 128 sheeting, plain weave):

Width Inches	Construction	Weight Oz./yd.^{2}	Warp	Filling	Total ends
40	64 X 64	4.8	21/1	23/1	3144

end breakage than the control lot. All of the lots had end breakage rate less than 30 per 1000-spindle hours, which was considered a practical limit for experimental laboratory spinning conditions. These data indicate that even when large amounts of either high or low Micronaire Reading cottons were used as components of mixes, spinning efficiency was not affected materially.

Yarn Strength

Figure 4 shows the differences in skein strength between the control and the experimental lots. For both warp and filling yarns, the strength of the experimental lots was less than the control. The percentage of coarse fibers used in the mix adversely affected the breaking strength of the yarn. There are more acceptable lots in the warp yarns than in the filling yarn, indicating that the added twist (warp twist) tends to offset some of the detrimental effects on yarn strength caused by the coarse fibers. To maintain yarn strength, yarn twist should be increased with increased coarse fibers in the mix. A practical application of this observation would be to use mixes containing high percentage of coarse fibers where high yarn twist is required, such as in warp yarns.

None of the warp and filling yarn elongations (data not shown) indicated any significant difference from the controls. Yarn elongation appears not to be affected by the Mirconaire Reading of components of the mix, irrespective of yarn twist.

Yarn Variation

Figure 5 shows the differences in yarn variability between the control and experimental lots. All lots, except filling Lot 3, produced yarns which were not as even as the control lot. However, the variabilities of all warp and filling yarns were less than the Uster yarn variability "standard" (dotted lines) established for these yarn numbers. It appears that yarns of commercially acceptable evenness can be produced from mixes containing various percentages of high and low Micronaire Reading cottons.

Yarn Grade

Table 4 shows the yarn grades of the control and experimental lots. The differences

Table 4. — Yarn grades [1] of control and experimental lots

Lots	Warp (21/1)	Filling (23/1)
C	C+	C+
1	C+	C+
2	C	C
3	C+	C
4	C+	C+
5	C+	C+
6	C	C+
7	C	C+
8	C	C

[1] All yarn grades are acceptable.

between the experimental and control yarn grades were relatively small. All mixes produced yarns of acceptable grades. The differences in card web nep count seemingly were not reflected in yarn appearance.

Fabric Strength

Figure 6 shows the fabric breaking strength obtained by the grab method of finished fabrics from the control and experimental lots. All lots had acceptable warp and filling direction grab strengths except for Lots 7 and 8 in the warp direction.

Grab breaking strength data of gray (data not shown) and finished fabrics revealed that the experimental lots had a greater percent loss in finished fabric strengths than the control lot in the warp direction, while in the filling direction, generally the experimental lots had less percent strength reduction than the control. Apparently, Micronaire Reading composition of the mixes was not directly associated with reduction in strength in the finished fabric.

Abrasion Resistance

The flex abrasion resistance (figure 7) of the finished fabrics were all acceptable.

Tear Resistance

Figure 8 shows the tearing strength of the fabrics obtained by the Elmendorf method. Because of frequent occurrence of "puckering" in the warp direction tearing tests, no statistical analysis was made of the warp data. Specimen puckering is a recognized problem for this type of measurement, and the trends shown should be accepted with reservation. Experience indicates that puckered samples tend to yield higher tearing strength than those specimens that do not pucker. The numerals above the bars in figure 8(A) represent the number of puckered specimens from a test set of 12 for each lot.

Figure 8(B) shows the average tearing strengths of nine specimens of each lot. The statistical analysis was based on nine observations per lot, because at least nine specimens of each lot were not puckered. The tearing strengths of Lots 6 and 7 were not acceptable. The Micronaire Reading compositions of these two lots gave no hint as to why their tearing strengths were low.

Marketability

The nine finished fabrics were compared with a finished mill control fabric, using normal mill marketability criteria. All of the eight experimental fabrics were judged to be marketable without price penalty. Savings from about $1.60 for Lot 1 to $9.60 for Lot 8 could therefore be realized when compared with rawstock cost of the control lot for every 500 pounds of cotton used. The mill evaluating panel cautioned that under mill conditions variations in mix composition and processing techniques necessarily would be higher than those in laboratory experiments. Evaluations presented herein should be considered with these factors in mind.

SUMMARY

Standard construction sheeting fabrics were produced from a series of mixes containing various percentages of extremely low and high Micronaire Reading cottons. Physical properties of yarn and fabrics were influenced by the Micronaire Reading of the cottons in the mix and the processing organizations. However, all of the fabrics were rated visually as commercially acceptable. Savings of about $1.60 to $9.60 per bale based on the price of the rawstock can be realized from mixes used in this experiment. In pilot plant experiments it is not possible to determine differences in processing and handling costs or the actual selling price of the fabrics, and therefore no specific overall savings for each mix can be stated. Mills considering application of these findings should evaluate the processing organizations and the yarn and fabric properties to select the mix that will meet their fabric quality requirements. It is probable that under mill conditions, variations in mix composition and processing techniques would be higher and result in greater differences in fabric appearance and properties than occur under laboratory conditions.

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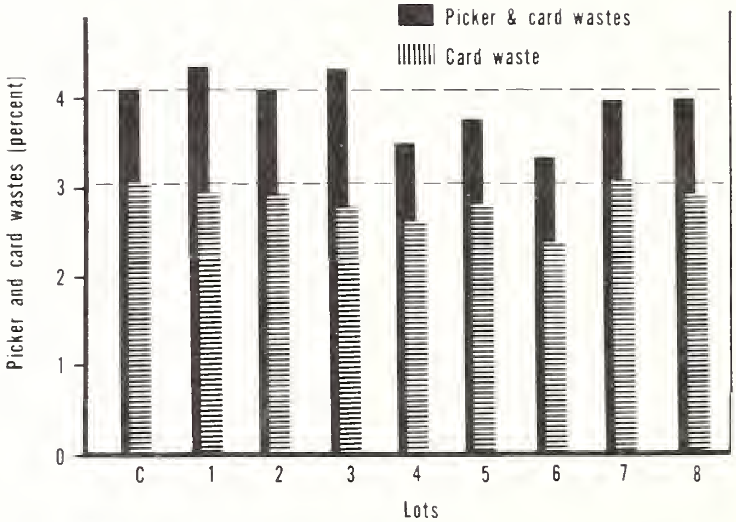

Figure 1. Picker and card wastes of control and experimental lots.

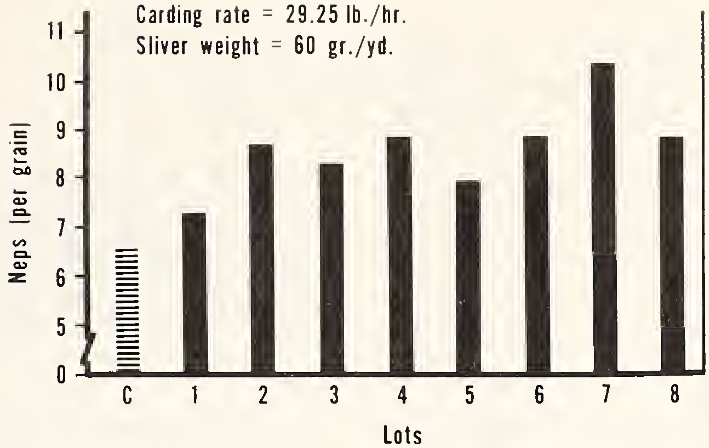

Figure 2. Neps in card webs of control and experimental lots.

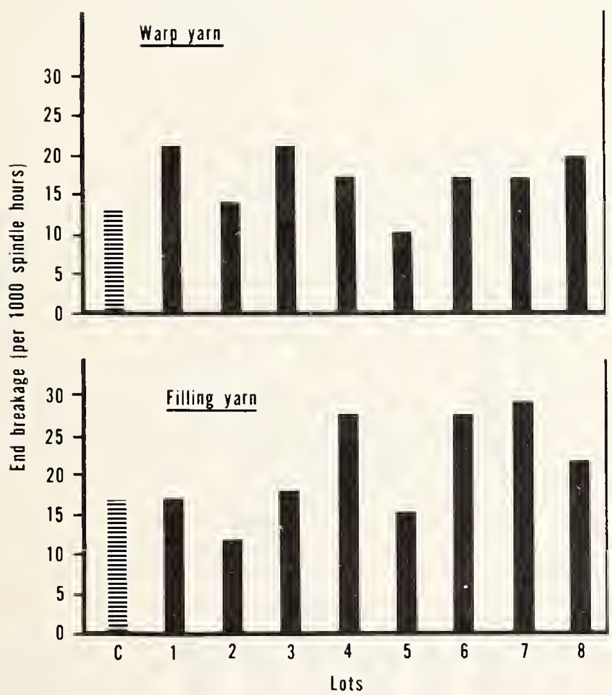

Figure 3. End breakage of control and experimental lots.

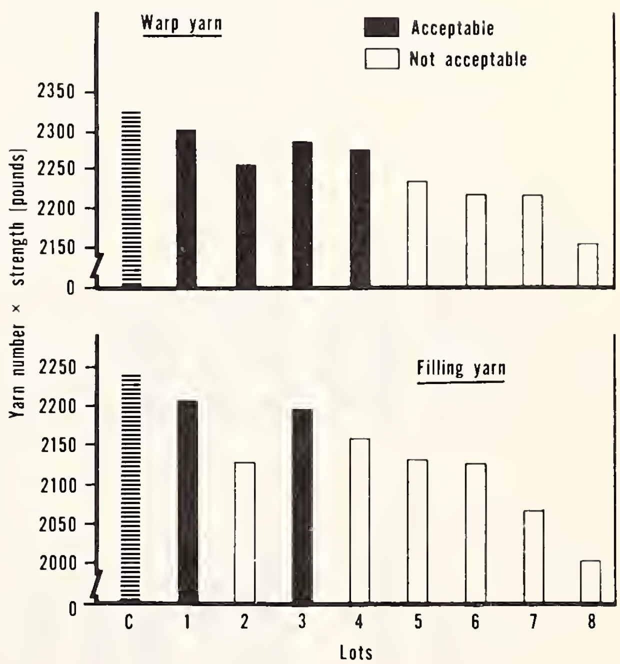

Figure 4. Skein yarn strength of control and experimental lots.

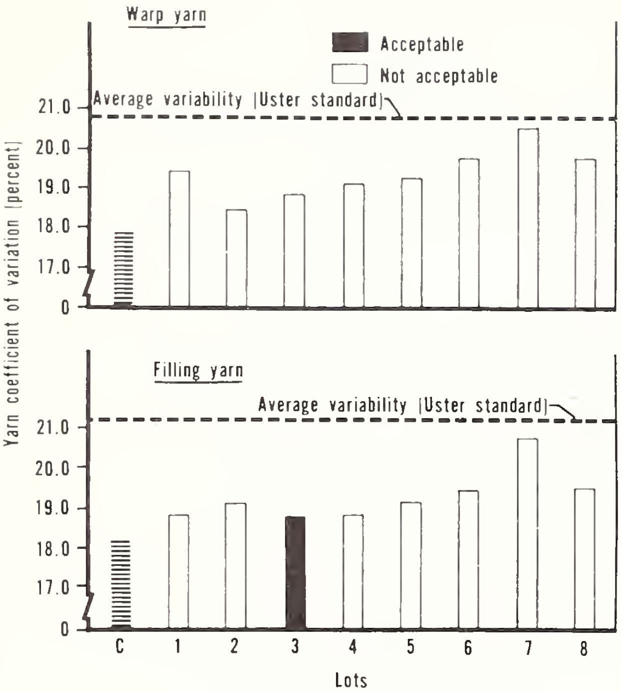

Figure 5. Yarn variability of control and experimental lots.

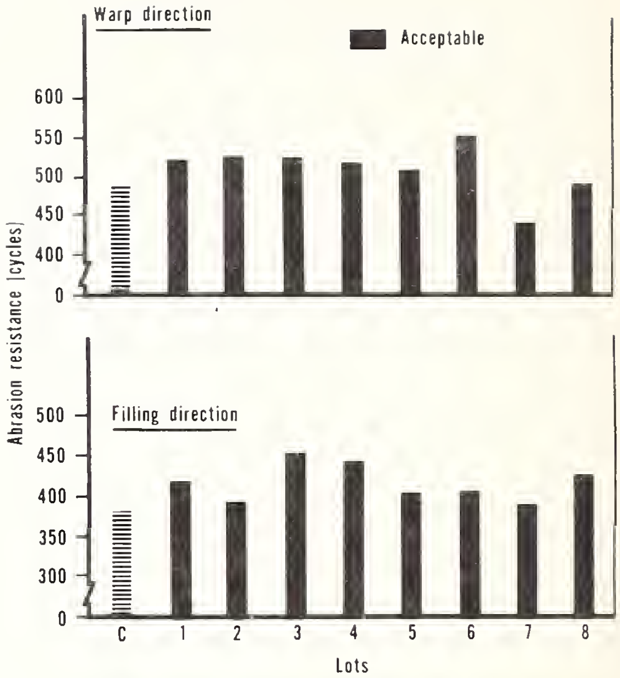

Figure 7. Flex abrasion resistance of finished fabrics from control and experimental lots.

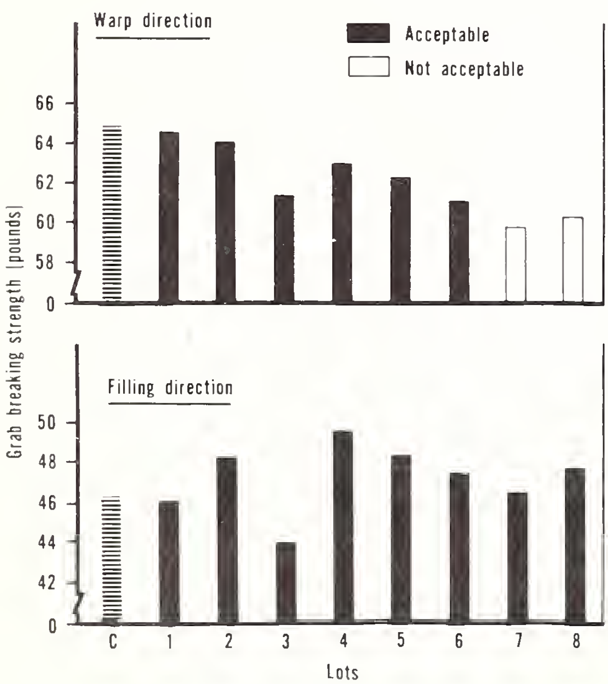

Figure 6. Grab breaking strength of the finished fabrics from control and experimental lots.

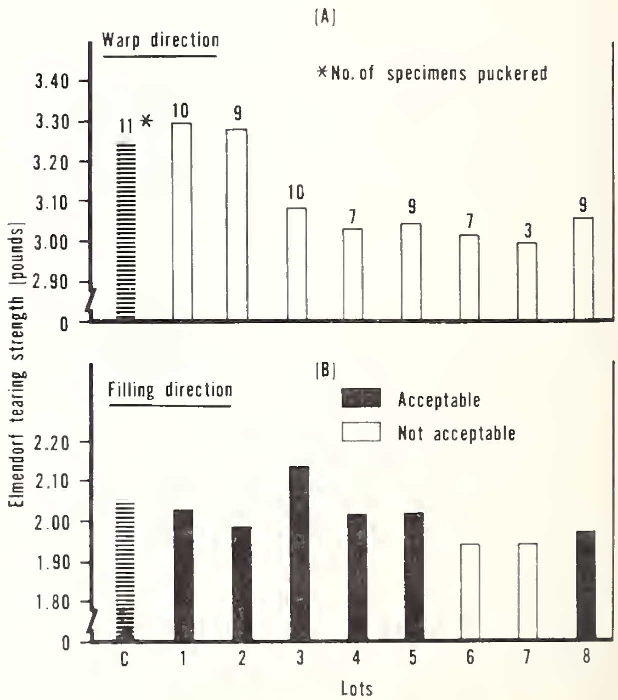

Figure 8. Tearing strength of finished fabrics from control and experimental lots.

UTILIZATION OF MEDIUM STAPLE DISCOUNT COTTON IN DENIM FABRICS

by

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In a continuing investigation of the feasibility of using low and high Micronaire Reading cottons in standard commercial fabrics, Bull Denim [2] fabrics were produced. The cottons, research techniques, and other pertinent data are described in the report on sheeting fabrics.

PROCESSING PROCEDURES

The mechanical processing variables and fabric specifications, which were furnished by the cooperating mill, are shown in table 1.

The gray fabrics were commercially finished by the cooperating mill, as follows:

1. Desized
2. Scoured
3. Washed
4. Mercerized
5. Bleached
6. Washed
7. Dyed (vat)
8. Starched
9. Sanforized

RESULTS

Waste

Figure 1 shows the picker and card wastes of the control and experimental lots.

Table 1. — Mechanical processing variables and fabric specifications

Picker lap wt. (oz./yd.)	15.0	
Carding:		
Production rate (lb./hr.)	32.0	
Sliver wt. (gr./yd.)	58.0	
Drawing:		
Delivery speed (ft./min.)	670	
Doubling (1st and 2d drawing)	8	
Sliver wt. (1st and 2d drawing)	75	
Roving size (hank)	0.5	
Spinning:	Warp	Filling
Yarn number	9.25/1	6.5/1
Twist Multiplier	4.37	3.80
Spindle Speed (r.p.m.)	6500	5500
Ring diameter (in.)	3	3
Traveler number	9	12
Draft:		
Back	1.64	1.64
Total	20.0	10.7

Fabric specification ("Bull Denim", 3 up 1 down left-hand twill):

Width Inches	Construction	Weight Oz./sq.yd.	Warp	Filling	Total Ends
50	68 X 44	11.5	9.25/1	6.50/1	3400

[1] One of the laboratories of the Southern Marketing and Nutrition Research Division, Agricultural Research Service, U. S. Department of Agriculture.

[2] Registered name of Graniteville Company.

Generally, the picking and carding processes did not preferentially remove fibers from the mixes containing cotton differing in Micronaire Reading. Except possibly for Lot 2, the differences noted were within the limits of experimental error.

Neps

Figure 2 shows card web nep comparisons between the control and experimental lots. Nep data were erratic. There appears to be no reason why Lots 1 through 5 had less neps than the control lot. Lots 7 and 8 containing no control cotton had more neps than the control lot. Differences noted, though large, may not be of practical significance since they did not appear to affect the yarn grades.

End Breakage

Warp and filling yarns were spun at traveler speeds of 5,120 and 4,330 feet per minute, respectively. The range of end breakages during 1,600 spindle hours per lot of warp spinning was from 2 to 6 for the nine lots, while in 800 spindle hours per lot of filling spinning the range was from 1 to 7. These ranges of end breakages in spinning are well within practical acceptable limits. Apparently the presence of extremes in Micronaire Reading in the cotton mixes did not adversely affect the efficiency of spinning 9.25/1 and 6.5/1 yarns.

Yarn Strength

Figure 3 shows the differences in skein strength between the control and the experimental lots. For both warp and filling yarns, the strength of Lots 6, 7, and 8, which contained a high percentage of coarse fibers was lower and not acceptable compared with the control. The strength of the warp yarn on Lot 1 was not acceptable, but the corresponding single strand yarn strength (data not shown) was acceptable. Lots 1 through 5 would be suitable blends for the coarse yarns used, since strength differences when compared with the control were negligible.

Yarn Variation

Figure 4 shows the differences in yarn variability between the control and experimental lots. Lots 6, 7, and 8 produced not acceptable warp and filling yarns, as did the warp yarn of Lot 2. However, variabilities of all warp and filling yarns with the exception of the warp yarn on Lot 6 were less than the Uster yarn variability. "standard" (dotted lines in figure 4) for these yarn numbers. This indicates that yarns of commercially acceptable evenness were produced on a laboratory basis from mixes containing various percentages of high and low Micronaire Reading cottons. In the event a mill produces a control yarn having a variability equal to or worse than the Uster standard, the experimental lots should follow the trend shown, and Lots 2, 6, 7, and 8 might then be outside acceptable mill tolerance.

Yarn Grade

Table 2 shows the yarn grades. Statistical analysis indicated that some yarn grades were not acceptable; none was more than a third of a grade lower than Lot C for the warp yarns, and two-thirds of a grade lower for the filling yarns. These differences were not reflected in the finished fabrics.

Table 2. — Yarn grades of control and experimental lots

Lots	Warp (9.25/1)	Filling (6.5/1)
C	B	B+
1	B*	B-
2	B-	B+*
3	B-	B-
4	B-	B*
5	B- *	B
6	B-	B
7	B-	B*
8	B*	B

*Acceptable; all others are not acceptable when compared with the control.

Fabric Strength

Figure 5 shows the fabric breaking strength obtained by the grab method of finished fabrics. Except for Lot 1, the warp direction grab strengths of the experimental lots were about 5 percent lower than the control lot and, therefore, were not acceptable. Lots 1, 4, 6, and 8 had acceptable filling direction grab

strength. The losses in strength for certain experimental lots, which occurred for both warp and filling directions, may or may not be important, depending on the requirements of the end product.

No trend could be found in the grab strength differences between gray and finished fabrics. Some finished fabrics lost a little more strength than others in the warp direction; none lost over 9 percent of its gray fabric strength. Some finished fabrics gained and some lost strength in the filling direction; none deviated more than 8 percent from its gray fabric strength. Micronaire Reading composition of the mixes apparently had no serious effects on gray to finished strength.

Tear Resistance

Figure 6 shows the tearing strength of the finished fabrics obtained by the Elmendorf method. Tearing strength values of the experimental fabrics in the warp and filling directions were all acceptable, with the exception of Lot 8 in the filling direction. Many lots had tearing strengths slightly higher than the control lot. Since denim fabrics mainly go into casual and sports apparel, which are associated with action and swift movement, good tearing strength may be more essential than breaking strength. All of the mixes containing cottons differing in Micronaire Reading would be satisfactory for this use.

Fabric Structure

Table 3 shows the constructions of the finished fabrics. In fabric width, the experimental lots deviated at most ±0.1 inch from the width of Lot C. The number of warp yarns per inch was 72 for all lots, while most of the experimental lots had two filling yarns less per inch than the control. In fabric weight, the experimental lots deviated a maximum of ±0.2 oz./sq. yd. from the weight of Lot C. It may be concluded that the experimental fabrics were stable and had good dimensional stability as compared with the control.

Marketability

A mill marketing panel compared the nine finished fabrics with the mill's control fabric and with mill marketability criteria. There was no perceptible difference in fabric appearance and dyeing characteristics between the experimental fabrics and the mill fabric. All experimental fabrics were judged to be marketable without price penalty.

Table 3. — Constructions in finished fabrics of control and experimental lots

Lots	Width Inches	Construction	Weight Oz./sq.yd.
C	47.5	72 X 46	11.1
1	47.6	72 X 47	11.2
2	47.6	72 X 44	10.9
3	47.6	72 X 44	11.0
4	47.5	72 X 44	10.9
5	47.5	72 X 44	11.0
6	47.6	72 X 44	11.3
7	47.4	72 X 44	10.9
8	47.4	72 X 44	10.9

Potential Savings

It is recognized that in normal production of denim fabrics, a 1-inch staple nondiscount cotton should be satisfactory for 6/1 and 9/1 yarns. Therefore, compared with 1-inch standard quality cotton, using 1-1/16-inch discount cottons might not result in any rawstock cost savings but could result in yarn and fabric quality improvement.

It is also recognized that under mill conditions variations in mix composition and processing controls would be higher than those in laboratory experiments, thus influencing the results. Nonetheless, the availability of medium staple length discount cotton on the market and the findings reported here suggest the commercial possibiliities of these cottons.

SUMMARY

This investigation indicates that marketable denim-type fabric can be produced from extremely high and low Micronaire Reading cottons, using normal mill processing organizations. Possible cost savings are dependent upon the raw stock normally used by the mill, and the yarn and fabric qualities being sought.

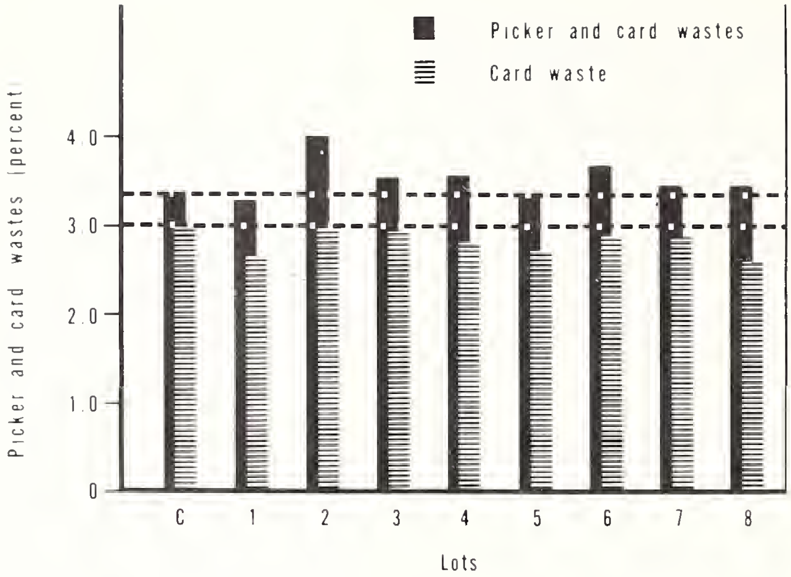

Figure 1. Picker and card wastes of control and experimental lots.

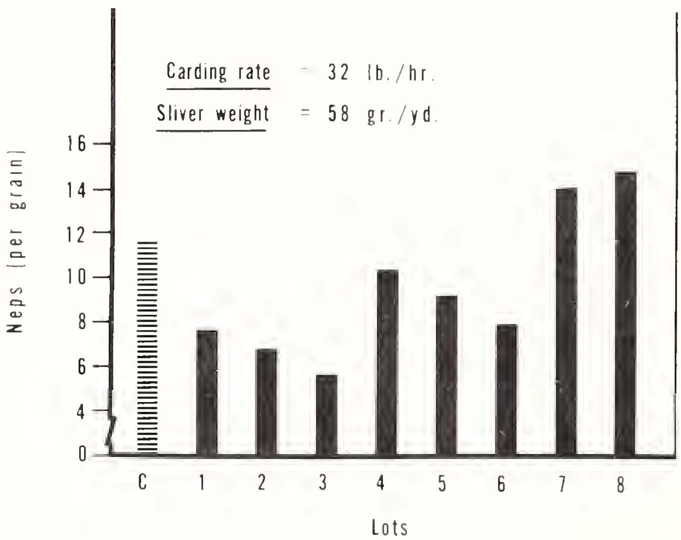

Figure 2. Neps in card webs of control and experimental lots.

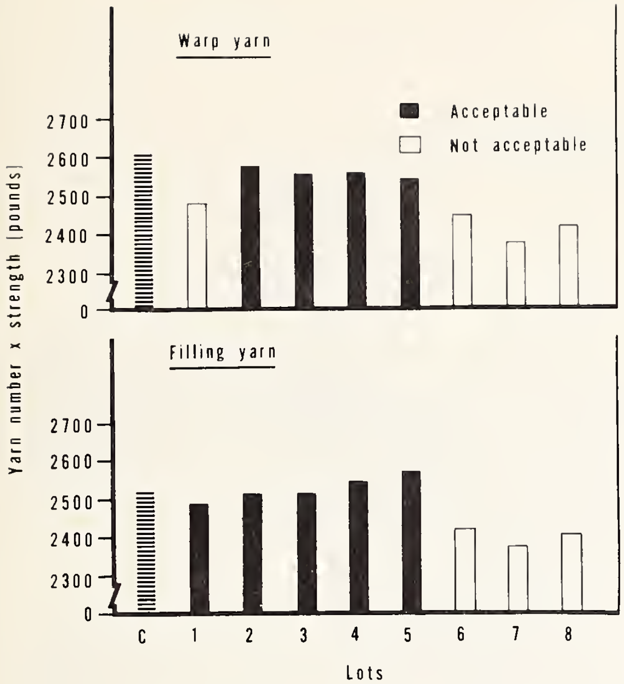

Figure 3. Skein yarn strengths of control and experimental lots.

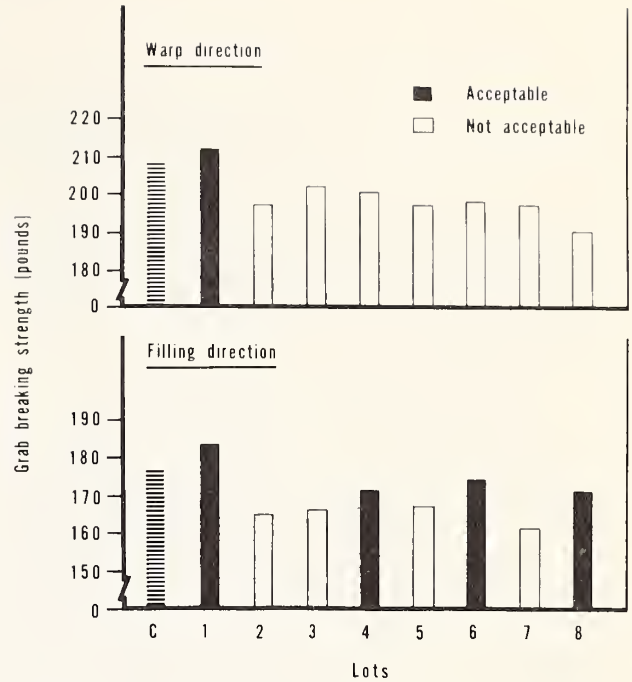

Figure 5. Grab breaking strengths of finished fabrics from the control and experimental lots.

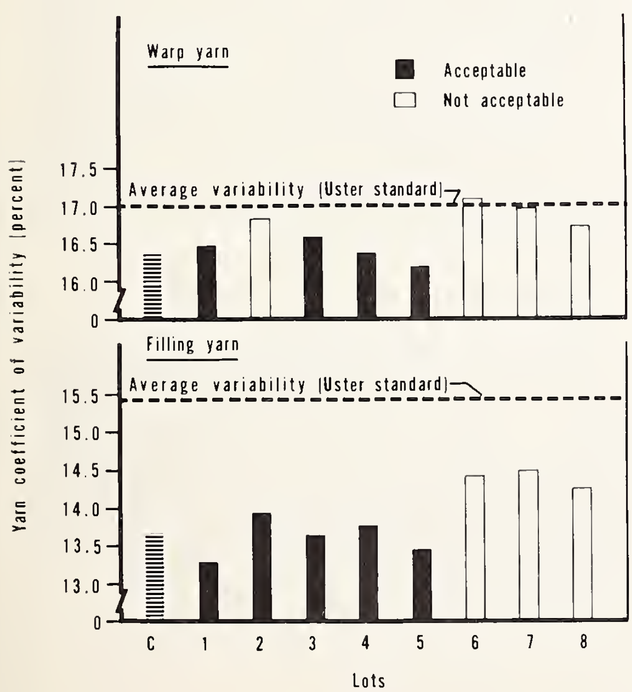

Figure 4. Yarn variabilities of control and experimental lots.

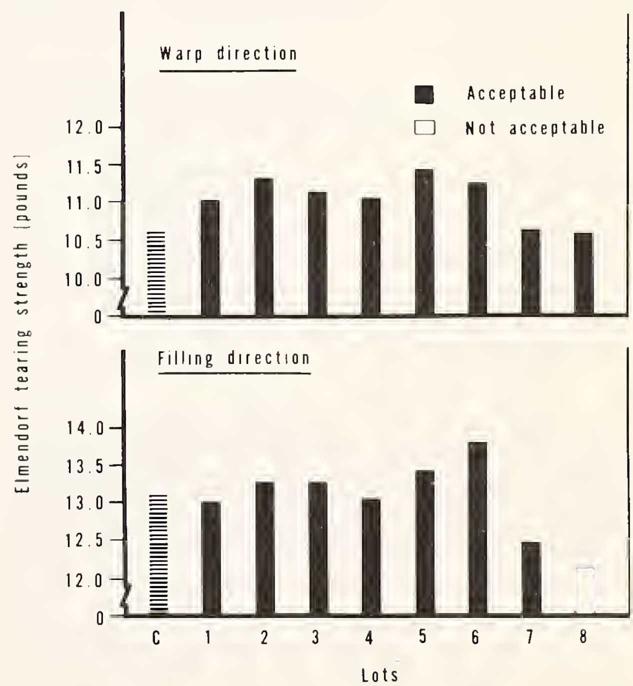

Figure 6. Tearing strengths of finished fabrics from control and experimental lots.

UTILIZATION OF MEDIUM STAPLE DISCOUNT COTTON IN PRINTCLOTH

by

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Southern Regional Research Laboratory [1]
New Orleans, Louisiana

This research reports using low and high Micronaire Reading cottons in printcloth. The cottons, research techniques, and other pertinent data are described in the report on sheeting fabrics.

PROCESSING PROCEDURES

The mechanical processing variables and fabric specifications, which were furnished by the cooperating mill, are shown in table 1. Lot C, lots 1 through 8 were processed with organization normally used in the Laboratory for medium staple length cotton. The H lots (C-H, 3-H, and 6-H) were processed with organization very closely approximating those furnished by the cooperating mill, and the A lots (C-A, 3-A, and 6-A) were processed using an organization averaging between Mill and Laboratory. Major differences in organizations are card production rates and spinning drafts, where "H" represents high carding rate and spinning draft, and "A" represents average carding rate and spinning draft when compared with the normal Laboratory processing organization.

The gray fabrics were commercially finished by the cooperating mill, as follows:

1. Singed
2. Desized
3. Scoured
4. Caustic boiled (rope form)
5. Scoured
6. Peroxide bleached (rope form)
7. Scoured
8. Mercerized
9. Neutralized
10. Resin treated (crease resistant finish)
11. Dried

Half of the bleached fabrics were dyed, but since the dyed fabrics showed similar trends to those of the bleached fabrics, only the bleached fabric data are discussed in this report.

RESULTS

Neps

Figure 1 shows card web nep comparisons between the control and experimental lots. Seven out of eight experimental lots carded at 25 lb./hr. had acceptable nep count. When carded at 35 lb./hr., nep counts of Lot C-A and Lot 3-A were acceptable; at 44 lb./hr. the three lots were not acceptable.

End Breakage

End breakage rate in spinning is presented in figure 2. Most of the experimental lots for the warp had higher breakage rate than the control. Four of the experimental filling lots had higher end breakage rates than the control. Five of the six lots carded at higher rates than the control lot had end breakage rates below that of the control. These results indicate that the end breakage rate for warp yarns was not seriously affected by increased carding rate, higher spinning drafts, or Micronaire Reading components in the various mixes. A similar observation can be made for filling yarns, except that spinning draft was constant for all organizations. Generally, end breakage rates were not excessive for any of the lots, considering that the linear traveler speeds were about 7,080 and 6,500 feet/minute for the warp and filling, respectively.

Yarn Strength

Figure 3 shows differences in skein strength between the control and the experimental lots. As the percent of low and high Micronaire Reading cottons increased in the mix, skein strength for both the warp and filling yarns decreased. None of the lots carded at 35 and 44 pounds per hour produced acceptable yarn strengths except Lot C-A.

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[1] One of the laboratories of the Southern Marketing and Nutrition Research Division, Agricultural Research Service, U. S. Department of Agriculture

Table 1. — Mechanical processing variables and fabric specifications

Item	Lots: C, 1 through 8	Lots: C-A 3-A 6-A	Lots: C-H 3-H 6-H
1. Picker lap wt. (oz./yd.)	14	14	14
2. Carding:			
Production rate (lb./hr.)	25	35	44
Sliver wt. (gr./yd.)	55	56	58
3. Drawing:			
Delivery speed (ft./min.)	800	610	425
Doubling: 1st drawing	8	6	6
Doubling: 2d drawing	10	8	6
Sliver wt. (gr./yd.)			
1st drawing	55	57	59
2d drawing	55	55	56
4. Roving (hank)	[1] 1.03(W) 1.13(F)	0.78(W) 1.13(F)	0.62(W) 1.13(F)
5. Spinning:			
Draft:			
Back	1.64	1.64	1.64
Total	30(W) 30(F)	40(W) 30(F)	50(W) 30(F)

	WARP	FILLING
Yarn number	31/1	34/1
Twist multiplier	4.25	3.77
Spindle speed (r.p.m.)	12,000	11,000
Ring diameter (in.)	2-1/4	2-1/4
Traveler number	6/0	7/0

6. Fabric specifications (Plain weave):

Width Inches	Construction	Weight Oz./sq.yd.	Warp	Filling	Total ends
39	80 X 72	3.70	31/1	34/1	3144

[1] (W) — for warp yarns
(F) — for filling yarns

Yarn Variation

Figure 4 shows the yarn variability of the control and experimental lots. In general, variability increased with decreased cost of the mix. Acceptability of the experimental lots was random. The experimental lots had higher yarn variabilities than the control lot. However, the variabilities of all warp and filling yarns were less than the Ustér yarn variability "standard" (see dotted lines on graph) for the yarn numbers used in this study.

On a laboratory scale, yarns of commercially acceptable evenness can be produced from mixes containing various percentages of high and low Micronaire Reading cottons. In the event a mill produces a control yarn having a variability equal to or worse than the Uster standard, the experimental lots should follow the same trend as shown. As a result, most of the experimental lots might be outside of the acceptable mill tolerance levels.

Yarn Grade

Figure 5 shows the yarn appearance grade of the control and experimental lots. Statistical analysis indicated that some of the experimental yarn grades were not acceptable, but none was more than two-thirds of a grade lower than Lot C. The differences in yarn grade were not sufficient to detract from the appearance and marketability of the finished fabrics.

Fabric Strength

Figure 6 shows the grab breaking strength of the finished fabrics. Warp and filling direction grab strengths were all considered acceptable regardless of mixes and processing organizations used. It is noteworthy that yarns for certain experimental lots and processing organizations whose skein strengths were not acceptable produced fabrics with acceptable grab strengths. Perhaps the finishing processes, particularly mercerization, may have evened out yarn strength differences associated with the experimental lots. Therefore, if a mill's printcloth quality criteria are grab strength and appearance, the mixes represented by the experimental lots might be used with substantial savings in rawstock costs.

Figure 7 shows the percent fabric strength reduction between gray and finished fabrics of the control and experimental lots. No trend in fabric strength reduction could be established. Some experimental lots had greater and some less fabric strength losses than the control after finishing. Apparently low or high Micronaire Reading cottons, or both, in a mix did not affect strength reduction.

Tear Resistance

Tearing strength of the finished fabrics was obtained by the Elmendorf method (data not shown). All of the tearing strengths of the experimental fabrics were acceptable except Lots 5 and 8 in the warp direction and Lot 7 in the filling direction of tear.

Abrasion Resistance

Figure 8 shows the Stoll flex abrasion resistance of finished fabrics from the control and experimental lots. All the lots carded at 25 pounds per hour produced fabrics with acceptable abrasion resistance. Lots C-A, 6-A, C-H, and 3-H, which were carded at higher rates and spun at higher drafts, produced fabrics with not acceptable abrasion resistance in the warp direction. The high drafts used in warp spinning produced hairier and perhaps loftier yarns, which might account for their low abrasion resistance.

Fabric Construction

Table 2 shows width, construction, and weight of the finished fabrics. The slight deviations in width, weight, ends and picks of the experimental fabrics from the control fabric indicated that the experimental fabrics were quite stable during chemical finishing. Different Micronaire Reading components in the mixes did not affect finished fabric construction.

Table 2. — Bleached fabric constructions of control and experimental lots

Lots	Width	Construction	Weight
	Inches		Oz./sq.yd.
C	35.9	86 × 68	3.36
1	35.9	85 × 66	3.33
2	36.0	85 × 70	3.41
3	35.9	85 × 65	3.38
4	36.0	86 × 67	3.44
5	36.0	86 × 67	3.37
6	35.9	86 × 67	3.41
7	36.2	86 × 67	3.32
8	35.8	85 × 66	3.39
C-A	35.7	86 × 68	3.40
3-A	35.8	86 × 70	3.46
6-A	35.9	84 × 67	3.33
C-H	35.9	86 × 69	3.31
3-H	35.8	86 × 65	3.37
6-H	35.0	87 × 66	3.49

Marketability

All of the 15 bleached fabrics evaluated by the cooperating mills were considered marketable. Table 3 shows the relative rankings of the experimental lots in comparison with the control. The left-hand column of part 1 shows that four experimental lots were better and four worse than the control lot when the cottons were carded at 25 lb./hr. At higher carding rates, the experimental lots all ranked better than the control lots. When comparisons

Table 3. — Fabric marketability ranking of control and experimental lots

1. Within series comparison:

Lots carded at 25 lb./hr.		Lots carded at 35 lb./hr.		Lots carded at 44 lb./hr.	
Best	8	Best	6-A	Best	6-H
	3		3-A		3-H
	6	Worst	C-A	Worst	C-H
	2				
	C				
	7				
	5				
	4				
Worst	1				

II. Among series comparison of specific lots:

	Control sample	Lot 3	Lot 6
Best	C	3	6
	C-A	3-H	6-H
Worst	C-H	3-A	6-A

were made of comparable mixes carded at different rates (part 2), results were inconclusive. Fabrics produced at the lowest carding rate were the best, and two out of three of the 44 lb./hr. carding rate fabrics ranked higher than the 35 lb./hr. carding rate fabrics.

The dyed experimental fabrics were also considered marketable. The visual differences among the lots appeared smaller than for the bleached fabrics. Apparently dyeing masked minor visual differences.

SUMMARY

Printcloth fabrics of marketable quality were produced from a series of mixes containing various percentages of high and low Micronaire Reading cottons, using mill and experimental processing organizations. The fabrics were produced under laboratory conditions and commercially finished. Yarn and fabric properties were affected by the Micronaire Reading of the cottons in the mix. Processing costs cannot be calculated from laboratory scale experiments, and therefore no cost comparison could be made among the mixes except for rawstock costs.

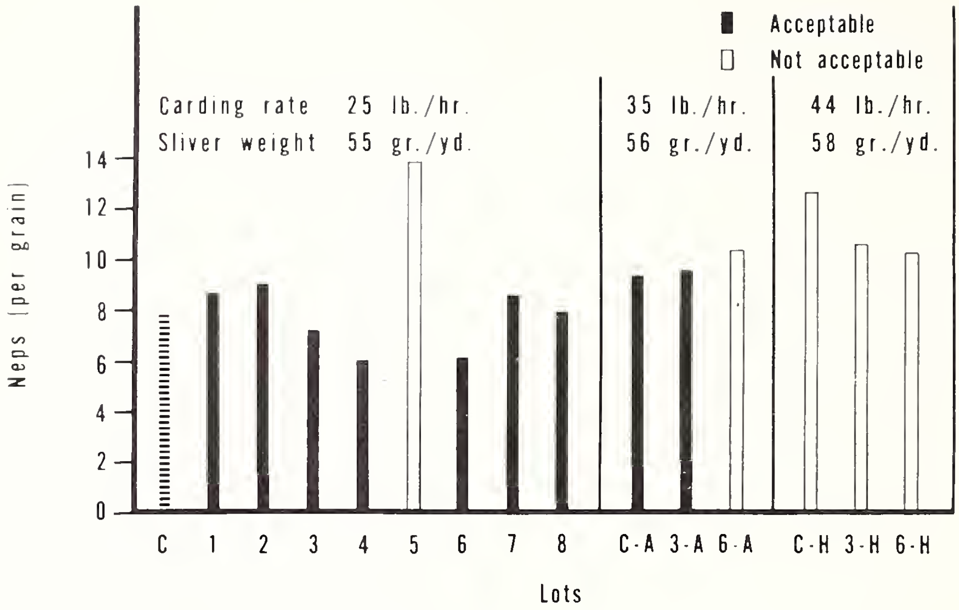

Figure 1. Neps in card web of control and experimental lots.

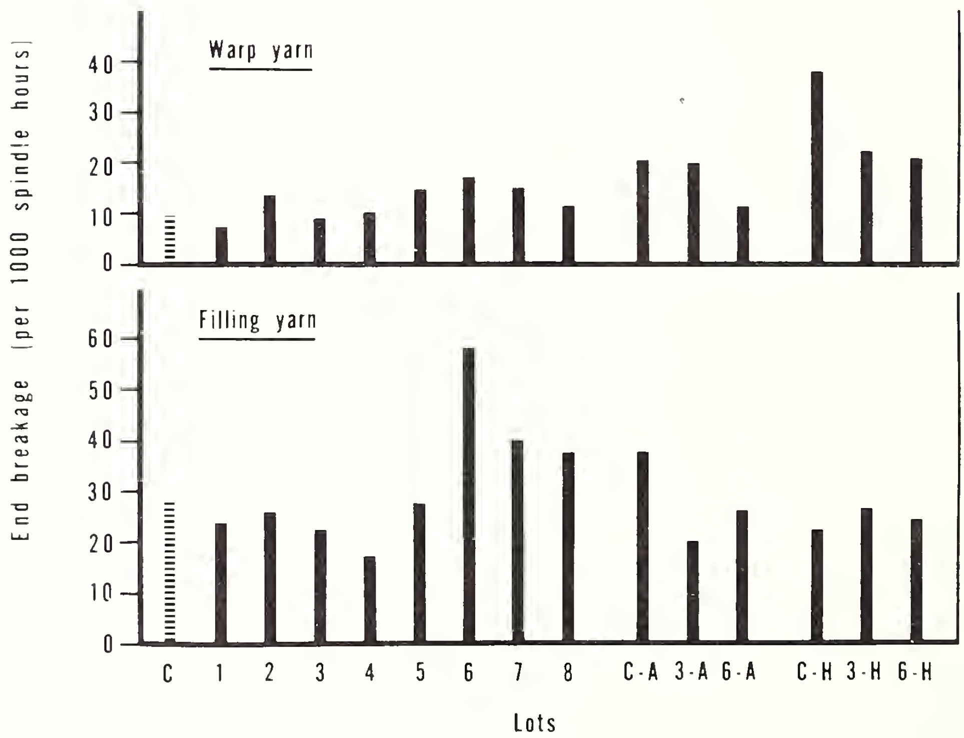

Figure 2. End breakage of control and experimental lots.

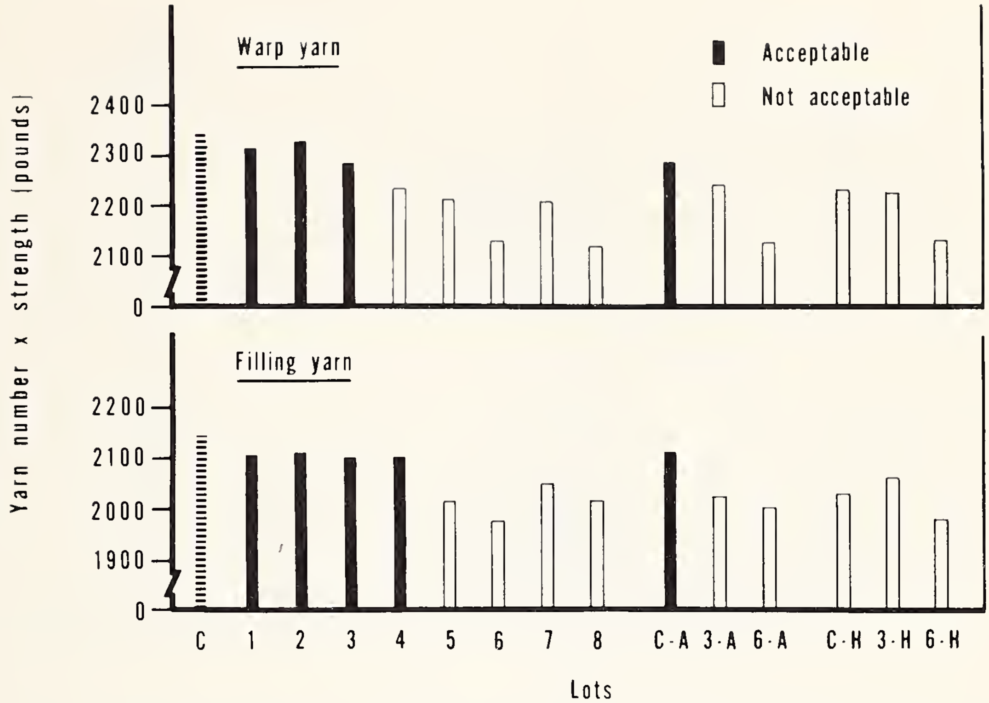

Figure 3. Skein yarn strength of control and experimental lots.

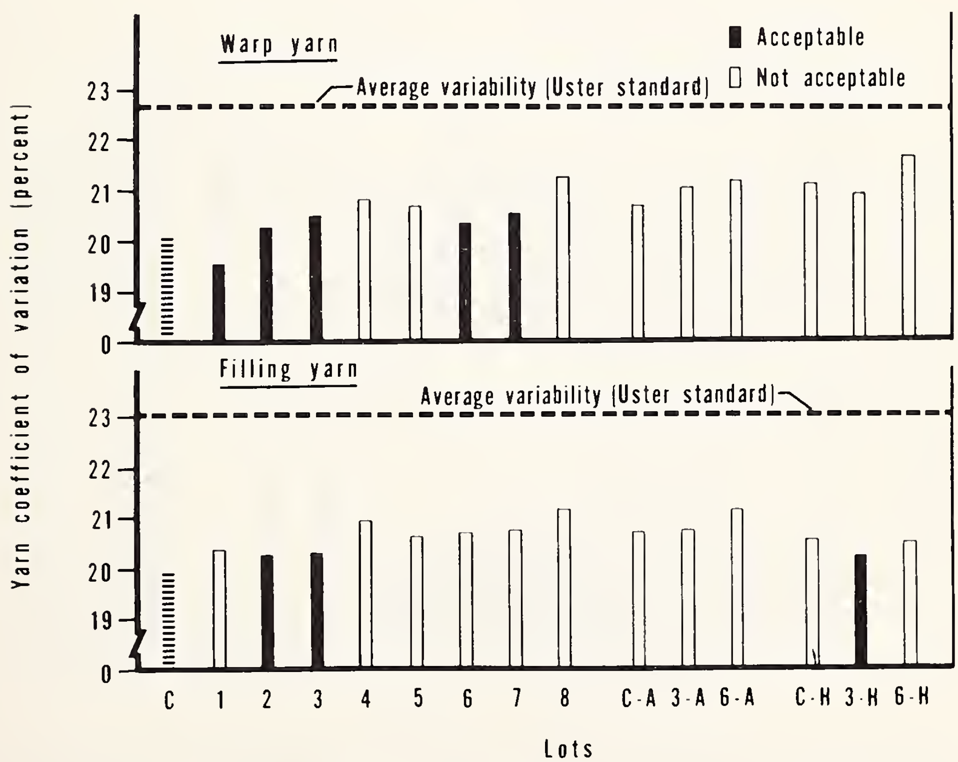

Figure 4. Yarn variability of control and experimental lots.

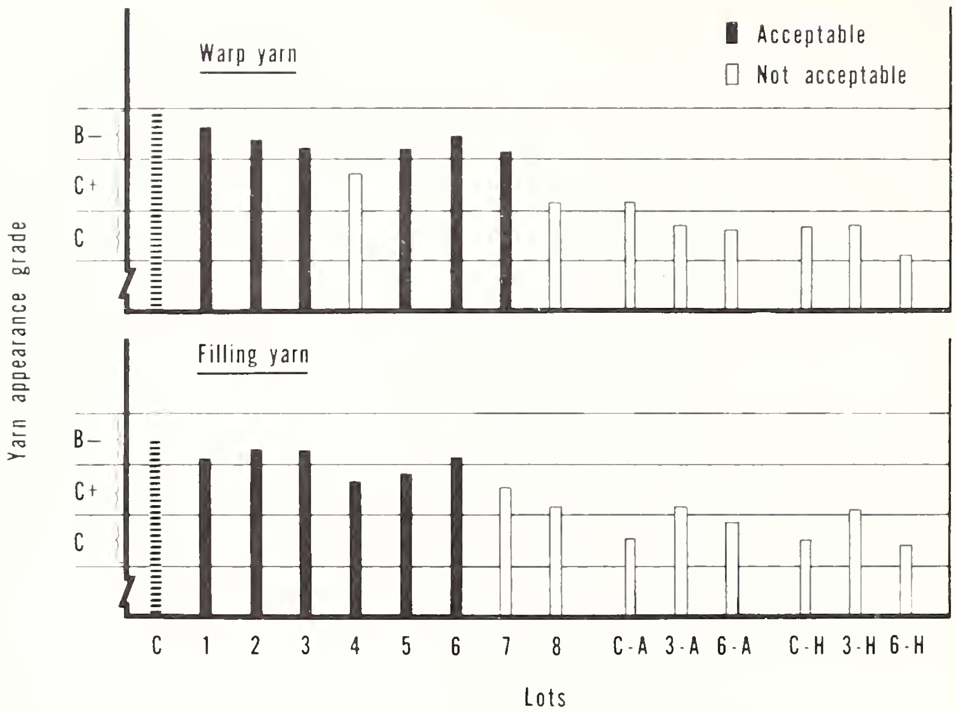

Figure 5. Yarn appearance grade of control and experimental lots.

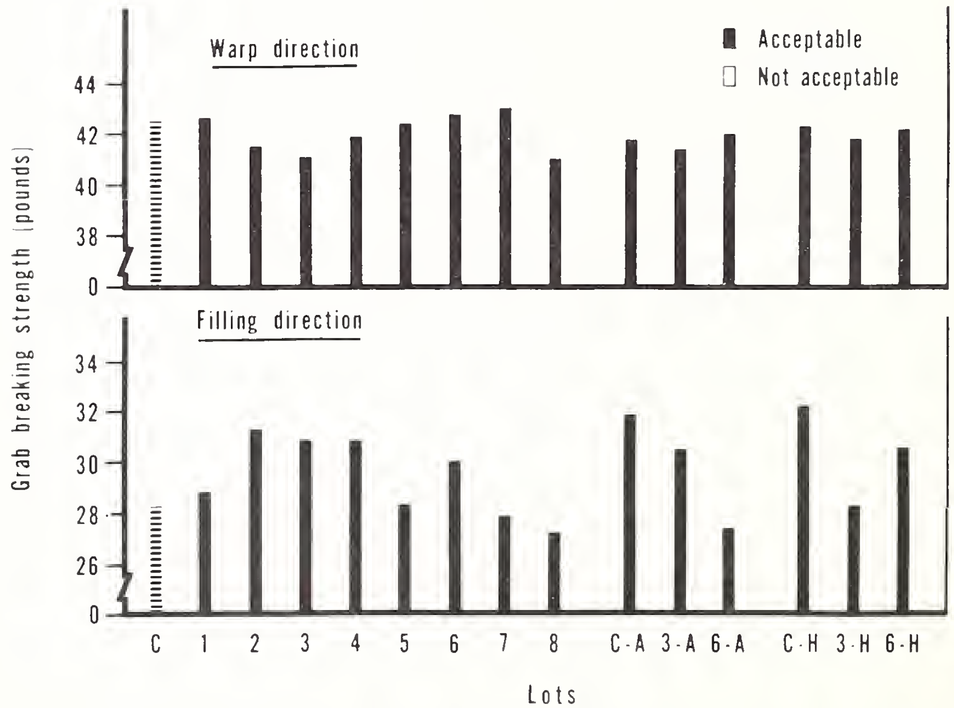

Figure 6. Grab breaking strength of finished fabric from control and experimental lots.

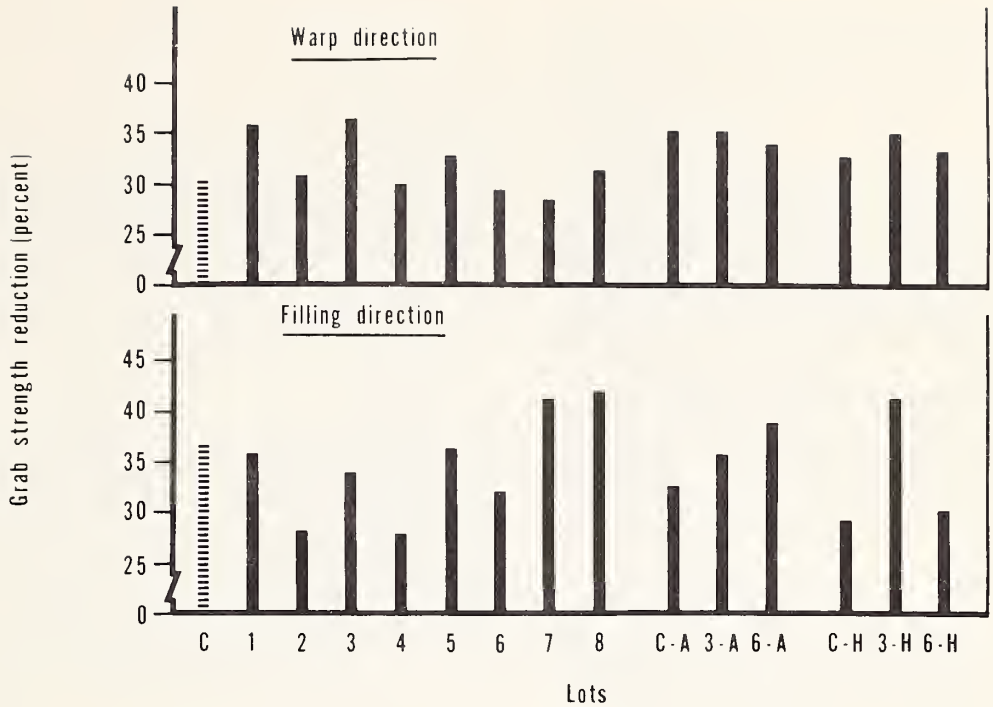

Figure 7. Fabric strength reduction between gray and finished fabrics of control and experimental lots.

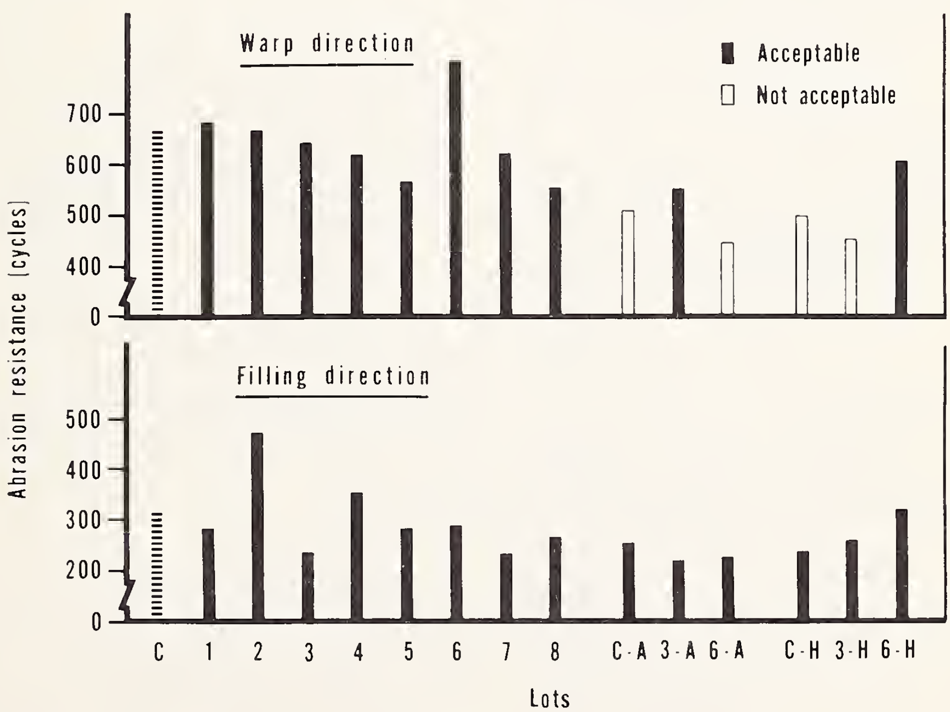

Figure 8. Flex abrasion resistance of finished fabric from control and experimental lots.

UTILIZATION OF MEDIUM STAPLE DISCOUNT COTTON IN TWILL FABRICS

by

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This research report on using low and high Micronaire Reading cottons in commercial fabrics describes the results with twill fabrics. Details of the cottons used, procedure, and other data are covered in the report on sheeting fabrics.

PROCESSING PROCEDURES

The twill fabrics were produced from Lots C, 3, 4, and 6. These lot numbers are maintained throughout this discussion for the sake of clarity.

The mechanical processing variables and fabric specifications, which were furnished by the cooperating mill are shown in table 1.

The gray fabrics were commercially finished by the cooperating mill, as follows:

1. Singed
2. Desized
3. Caustic boiled
4. Washed
5. Bleached
6. Mercerized
7. Washed
8. Dyed (vat)
9. Softener added
10. Dried
11. Mechanically shrunk

Table 1. — Mechanical processing variables and fabric specifications

Picker lap wt. (oz./yd.)	16	
Carding:		
Production rate (lb./hr.)	24	
Sliver wt. (gr./yd.)	60	
Drawing (1st and 2d drawing)		
Delivery speed (ft./min.)	815	
Doubling	8	
Sliver wt. (grain)	60	
Roving (hank)	0.6	
Spinning:	Warp	Filling
Yarn number	14/1	15.5/1
Twist multiplier	4.57	4.05
Spindle speed (r.p.m.)	10,750	9,000
Ring diameter (in.)	2-1/4	2-1/4
Traveler number	7	7
Draft:		
Back	1.27	1.27
Total	23	26

Fabric Specifications (3 up 1 down left-hand twill):

Width Inches	Construction	Weight Oz./sq.yd.	Warp	Filling	Total
48	107 × 54	8.82	14/1	15.5/1	5100

[1] One of the laboratories of the Southern Marketing and Nutrition Research Division, Agricultural Research Service, U.S. Department of Agriculture.

RESULTS

Waste

Findings on processing waste of the control and experimental lots were not consistent. Picker and Card waste ranged from 3.83 percent for Lot C to 4.29 percent for Lot 6. The differences between the control and experimental lots were considered not significant.

Neps

Lots C, 3, 4, and 6 had average nep counts of 8.1, 10.7, 10.0, and 7.8 per grain of card web, respectively. Two of the experimental lots had slightly more neps and one lot had slightly less neps than the control. This indicated that mixes containing low and high Micronaire Reading cottons can be carded without experiencing excessive card web neps.

Yarn Grade

There were no noteworthy differences in grade among the control and experimental warp and filling yarns. All grades were about B and were acceptable.

Yarn Strength

Figure 1 shows the skein yarn breaking strength of the control and experimental lots. All warp and filling yarns were acceptable except Lot 6 filling yarn. Lots 3 and 4 were slightly stronger than the control for both warp and filling yarns.

Yarn Variation

Figure 2 shows the yarn variability of the control and experimental lots. The filling yarn of Lot 6 was slightly more nonuniform than Lot C and was not acceptable. All other yarns were acceptable.

Fabric Strength

Figure 3 plots the grab breaking strength of the finished fabrics. Grab strength in the filling direction for the experimental fabrics was acceptable, while grab strength in the warp yarn direction was acceptable for Lot 6. The data indicate that strength differences between the control and Lot 4 (lowest in strength) was about 3.8 percent, and less for Lot 3. For all practical purposes the breaking strengths of Lots 3 and 4 could be acceptable to mills producing this type twill fabric.

Tear Resistance

Figure 4 shows the tearing strength of the finished fabric for the control and experimental lots. Warp direction tearing strength of the experimental lots was not acceptable. The difference between the control and the lowest tearing strength (Lot 3) was 0.93 pounds, or about 7.5 percent lower than that of the control. The experimental lots were acceptable in the filling direction; the difference in the tearing strength among lots was small.

Abrasion Resistance

Figure 5 shows the abrasion resistance of the finished fabrics measured on the Stoll abrader. All experimental fabrics had acceptable abrasion resistance with the exception of Lot 6 in the filling direction. The warp direction abrasion resistance for all lots was much lower than that in the filling direction. This might be explained by the structure of the fabric (3 up 1 down left-hand twill) whereby the warp yarns on the surface of the fabric were more vulnerable to abrasion than the filling yarns.

Fabric Dimensional Stability

There were only very small differences in width, weight, and ends and picks of the experimental fabrics when compared with the control. The finishing operations did not affect the dimensional stability of the experimental fabrics.

Marketability

All fabrics compared favorably with the mill's commercial twill and were considered marketable without penalty points, based on visual appearance evaluations.

Potential Savings

A 1-1/16-inch standard quality cotton is too expensive for use in producing twill fabrics for most end uses. This study was conducted with the idea that 1-1/16-inch discount cotton might contribute to improved processing efficiency and product quality, compared with the 1-inch cotton normally used, and at the

same time open new markets for medium staple length extremely low and high Micronaire Reading cottons.

SUMMARY

Experimental twill fabrics were produced from mixes of low and high Micronaire Reading cottons in various proportions. The results indicate that such cottons can be processed with normal mill organizations into commercially marketable fabrics. Savings in raw cotton and processing costs may or may not result, depending upon the individual mill's present raw cotton costs, processing speeds, and product quality requirements.

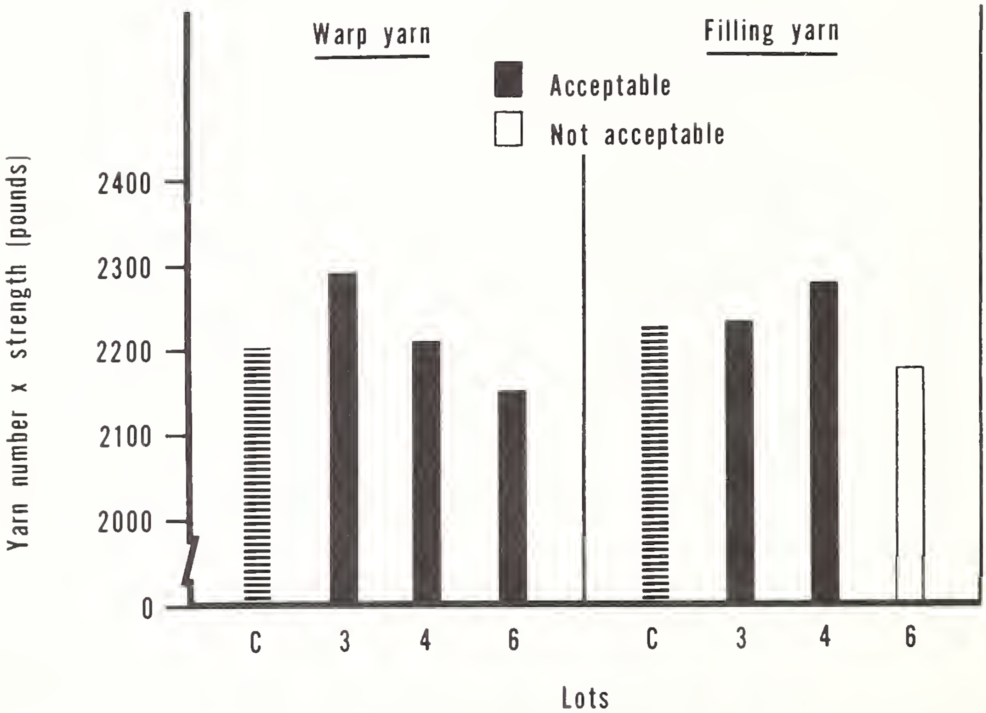

Figure 1. Skein yarn strength of control and experimental lots.

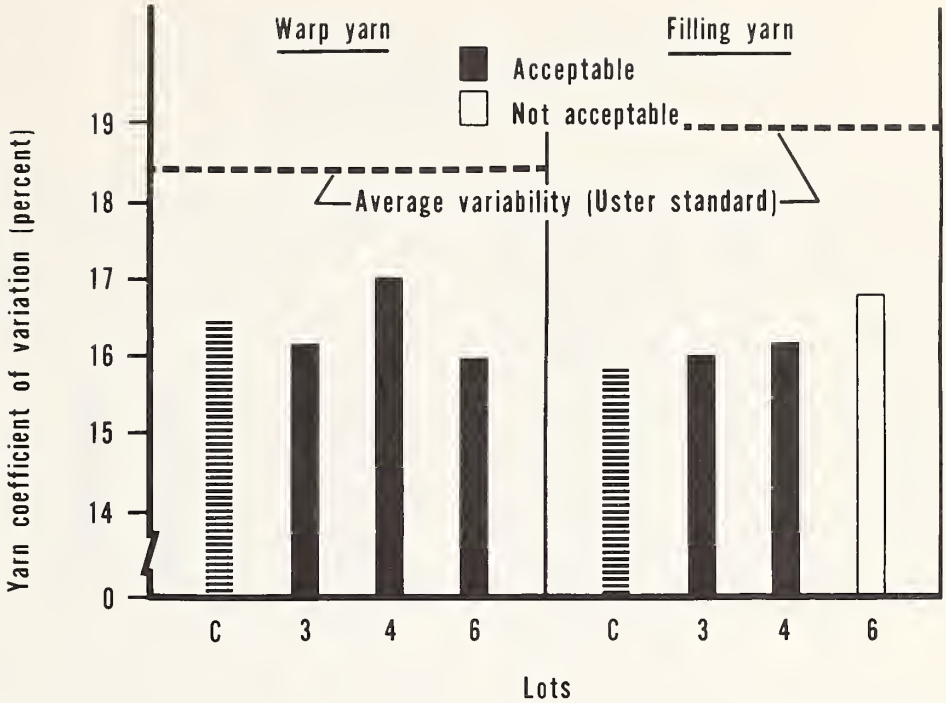

Figure 2. Yarn variability of control and experimental lots.

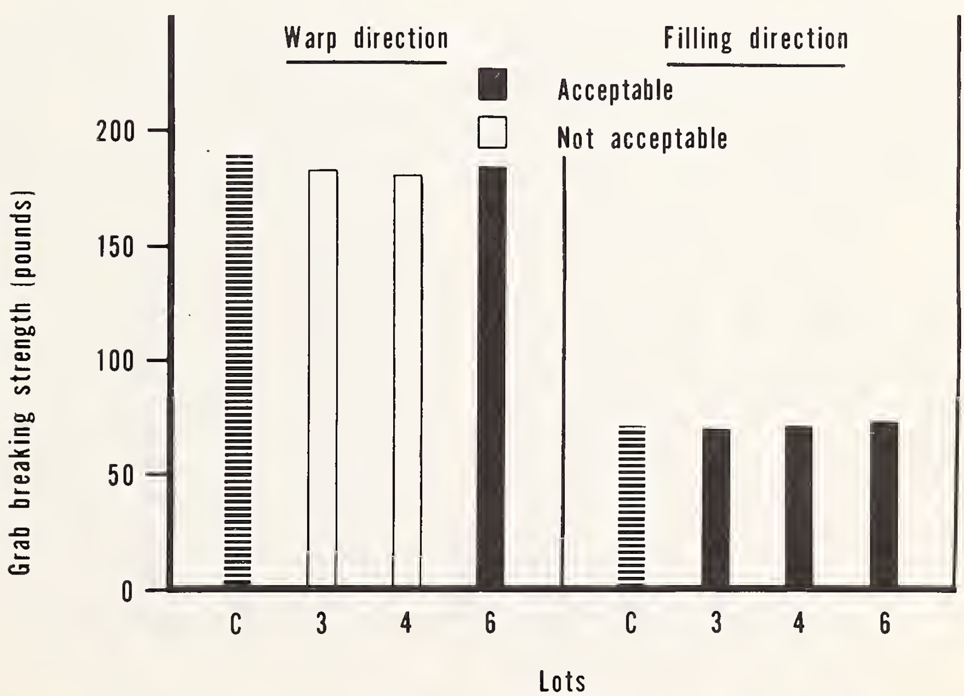

Figure 3. Grab breaking strength of finished fabric from control and experimental lots.

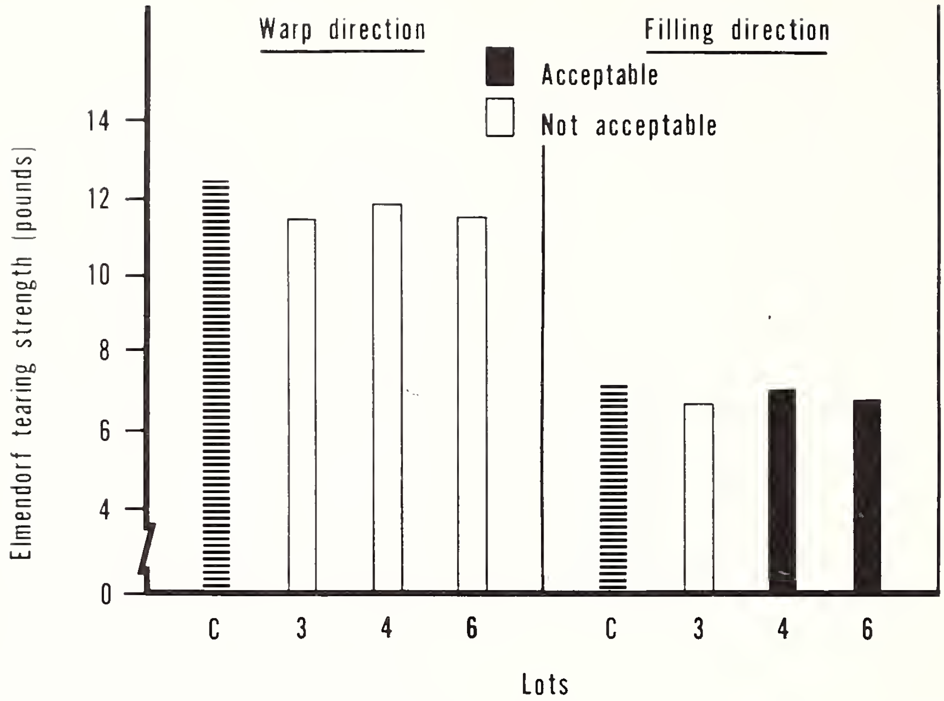

Figure 4. Tearing strength of finished fabric from control and experimental lots.

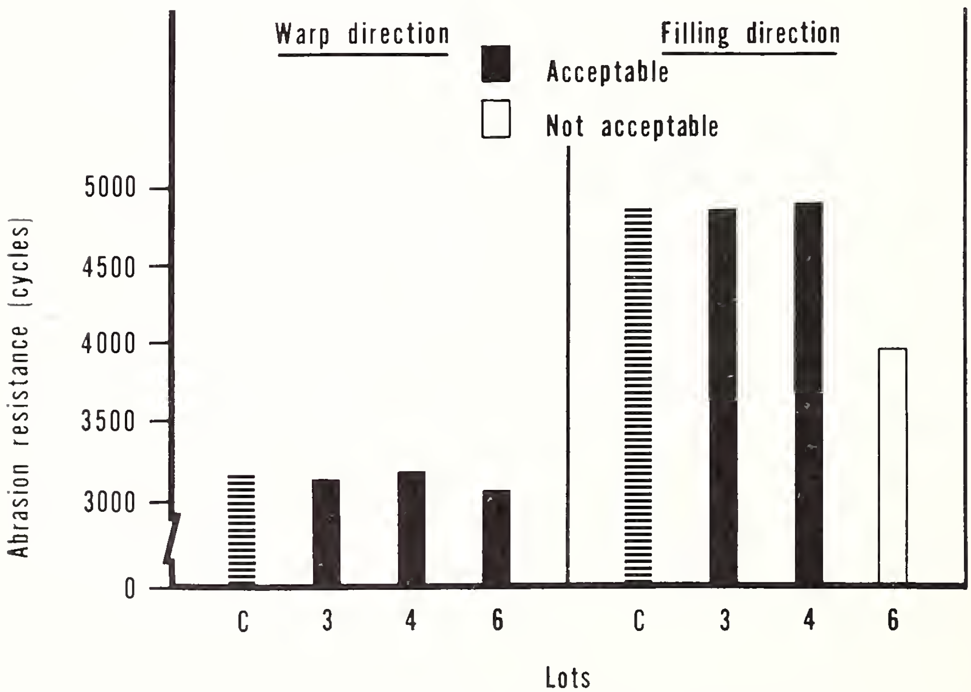

Figure 5. Flex abrasion resistance of finished fabric from control and experimental lots.

MECHANICAL PROCESSING AND BLENDING TECHNIQUES FOR SHORT STAPLE DISCOUNT COTTONS [1/]

by

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The utilization of low and high Micronaire cottons is a major problem in the cotton industry. Small quantities of low and high Micronaire cottons are used in blends with medium Micronaire cottons. However, there is little demand for 3.2 and lower Micronaire cottons except for use in low grade and specialty items where excess neps, higher waste, and lower processing efficiency can be offset by a heavy price discount for low Micronaire cottons. Cottons with Micronaire of 5.0 and higher produce yarns and fabrics that are lower in strength and uniformity but are nep-free and accept most dyes readily. When blends of low and high Micronaire are processed into yarn and fabrics, acceptable results generally can be obtained (2, 4). Recommendations have been made in the past to blend the finer fibers with coarser fibers (10). Fine cottons can be blended with coarse cottons to gain a price advantage and, under certain conditions, to obtain greater yarn strength for low cost fabrics (7, 8, 9).

Micronaire discounts for 1969 were as much as 390 points ($19.50 per bale) on the extra low Micronaire cottons and 135 points ($6.75 per bale) on the extra high Micronaire cottons. Cottons in the 3.5 through 4.9 Micronaire range sold at a premium of 45 points ($2.25 per bale). Therefore, if extra low Micronaire cottons were to be blended with extra high Micronaire cottons in the required controlled proportions to average a blend in the range of 3.8 to 4.2 and then could be compared favorably in processing conditions and in yarn quality with a premium cotton in the same average Micronaire range, a saving in the cost of cotton due to the Micronaire price differences could be as much as $12 to $13 per bale. If the 3.8 to 4.2 average blend should be composed of bales from the 2.7 through 2.9 range and the 5.0 through 5.2 range and then compared with the blend from the 3.5 through 4.9 cottons, the savings would be around $7.50 per bale.

If blends of high and low Micronaire can be processed satisfactorily and all other factors being equal, a mill can effect considerable saving in cotton cost. However, at a given carding rate, extreme variations in Micronaire reflect variation in waste percentages, neps in card web, trash content, and yarn appearance grades (9). Some discussions have been held on the feasibility of carding the low Micronaire at low carding rates and the high Micronaire at higher rates and blend the materials at the drawing frame. Others have pointed out that the further back in processing that the blend is made, the more intimate the fiber mixture (6) and that the Micronaire blend should be controlled by the harmonic mean of the mixture (1, 5).

The objectives of this study were to (1) determine the feasibility of hopper blending of various combinations of the low and the high Micronaire cottons of selected grades and staples to produce commercially acceptable yarns of optimum quality; (2) study the feasibility of drawframe blending of card sliver produced from low Micronaire cottons carded at a lower than normal rate, with a card sliver produced from high Micronaire cottons carded at a high carding rate; and (3) compare the processing efficiency and product quality of these blends with a control cotton of premium Micronaire cottons.

This study was planned to determine whether or not the various low and high Micronaire discount cottons could be blended together so that the merits of one would offset the demerits of the other when comparing processing conditions and yarn produced from premium Micronaire cottons in the 15/16-inch and 1-inch staple range. If this could be done, then the use of discount cottons could be greatly enhanced as the lowered cost to mills should be an added incentive for greater utilization.

[1/] A report of work done undr contract with U.S. Department of Agriculture and authorized by the Research and Marketing Act. The contract was supervised by the Southern Marketing and Nutrition Research Division, Agricultural Research Service, U.S. Department of Agriculture.

MATERIALS AND METHODS

The cotton was selected on the basis of instrument evaluations for color, length, and fineness. Seventy-two bales of 15/16-inch cotton and 72 bales of 1-inch cotton were selected for separate studies. Three combination grades were used as follows:

Grade Combination 1:

	Percent
SLM White	50
SLM Lt. Spot	50

Grade Combination 2:

SLM White	50
LM Lt. Spot	25
LM Spot	25

Grade Combination 3:

Mid. White	50
Mid. Lt. Spot	25
Mid. Spot	25

Based on 1969 loan rates for Lubbock, Texas, the various combination grades in 15/16-inch and 1-inch cottons would have a range in cost of up to 200 points and 235 points per pound, respectively, with Grade 2 being the lowest in price and Grade 3 the costliest.

The Micronaire of the cottons selected were designated extra low (EL-2.9 and below), medium low (ML-3.0 through 3.4), medium (M-3.5 through 4.9), medium high (MH-5.0 through 5.2), and extra high (EH-5.3 and above).

Figure 1 shows the overall makeup of the 144 bale study.

The processing equipment used in the study was standard size mill machinery using normal settings and speeds. Two of the five cards were used for high production, while three were used for low production.

The study began with the processing of Control Grade Combination 1, Staple 1-inch (shown as 2 in the abbreviations), replication 1, hopper blend (C-1-2-1-HB). Four bales were opened and fed through four weigh pan blending feeders and made into laps. The odd-numbered laps were designated rep 1 while the even-numbered laps were rep 2. The control cottons were carded at 25 pounds per hour. This procedure was repeated for Grade Combinations 2 and 3.

Six laps of Grade 1, Grade 2, and Grade 3 of the high, medium, and low (HML) study were processed at various carding rates — two laps at 15 pounds per hour, two laps at 25 pounds per hour, and two laps at 35 pounds per hour through one card to determine the best carding rate based on processing performance and yarn test results. The 25-pound carding rate was selected as optimum, and the balance of the HML blend for the three grades was processed at this rate.

Four bales of extra low Micronaire (EL) cotton and four bales of extra high Micronaire (EH) cotton were opened for the extra high-extra low (EHEL) study, Grade 1. Five laps were made from the EH cotton and five from the EL cotton. One full lap of the EL was processed at each of the following carding rates: 4, 6, 8, 10, and 12 pounds per hour. One full lap of the EH was processed at each of the following carding rates: 12, 20, 28, 36, and 44 pounds per hour through one card. These materials were processed through spinning under the same conditions. The study was repeated for Grade 3. Ten pounds per hour for the EL, 44 pounds per hour for the EH, and 27 pounds for the EHEL hopper blend were the carding rates selected for the EHEL study. The 27-pound rate was selected as being one-half the rate of EH plus EL.

The same procedure was used for the medium-high and medium-low Micronaire blend (MHML). The same carding rates were selected as in the EHEL study.

The 1-inch cotton was spun into 20's yarn at 11,000 spindle speed and a 4.00 twist multiplier.

The overall same procedure was used for the 15/16-inch cotton which was spun into 12's yarn at 9,000 spindle speed and a 4.00 twist multiplier.

Figure 2 shows the basic machinery layout using the four weigh pan blending feeders, the picker, two high-production cards, breaker and finisher drawing, roving, and spinning. This system was used for hopper blending on the controls, HML, one-half of the EHEL, and one-half of the MHML for the three grade combinations and the two staple lengths.

Figure 3 shows the basic machinery layout for drawframe blending using two cards on the high Micronaire cottons for the high-production carding and three cards for the low Micronaire low carding rate. This basic system was used for one-half of the EHEL and one-half of the MHML for the three grade combinations and the two staple lengths. Bar graphs 4 through 19 show average results on the blends for Pressley strength, nonlint percent, picker and card waste, card neps, ends down per 1,000-spindle hours, yarn breakfactor, yarn appearance grades, and Uster CV percent.

RESULTS AND DISCUSSIONS

In the selection of the cotton, the 2.5 percent span length measurements were kept at plus or minus three on both staple lengths. The bar graphs show the arithmetic average of the bales making a particular mix for the strength readings ("0" gage Pressley) and for nonlint percent (Shirley Analyzer).

The range in strength of the blends was from 73,000 to 80,000 p.s.i. on the 15/16-inch cotton and from 75,000 to 85,000 on the 1-inch cottons; however, the individual components did have a wider range. The nonlint content averaged from 1.8 to 4.0 percent on the 15/16-inch and from 2.4 to 4.3 percent on the 1-inch with individual bales as high as 4.7 and 5.8 percent respectively.

The neps per 100 square inches of card web were highest on the low Micronaire cottons when carded separately even though low carding rates were used. In the blends of the discount Micronaires, the EHEL study had a slightly higher nep count in two of the three grades.

The picker and card waste percentages of the samples ranged from as low as 3.5 percent on the extra high Micronaire cotton to about 8 percent on the extra low Micronaire. The picker and card waste was slightly lower on the MHML blend in three of the six cases. The HML hopper blend rated highest in the lowest number of EDMSH while the EHEL hopper blend was next.

The Uster CV percent overall percentages ranged from about 18 to 21 on the 12's yarn and 18 to 22 on the 20's yarn. These readings would have an adjective rating of about average. The MHML drawing blend had a slight edge in the better CV percent.

Much of the variation in break-factor possibly could be due to either Pressley strength or a high short fiber content; however, in some of the extra-low Micronaire cottons perhaps fiber breakage in processing tended to lower the break-factor. Overall, the control cottons had a slightly higher break-factor.

Yarn appearance grades of the 12's yarn were practically the same. More differences were noted in the 20's yarn grade which ranged from C to B in no particular pattern for the various blends.

No special problems occurred in processing. However, special care and extra precautions were taken to keep from mixing sliver on the breaker drawing blend. In some instances, we found variation of fiber properties inside the bale. The bales we purchased were bought on the basis of tests made on classer's samples.

CONCLUSIONS AND RECOMMENDATIONS

The results showed little or no significant differences between grades. A logical choice, therefore, would be to use the cheapest grade combination which is Grade 2-50 percent Strict Low Middling White, 25 percent Low Middling Light Spot, and 25 percent Low Middling Spot. This combination was 235 points cheaper than Grade 3.

The data lacked any consistent pattern wherein one Micronaire blend was better or worse than others. This in itself indicates that the various combinations of Micronaire blending are feasible and compare favorably with the control cottons. Again, the recommendation would be to blend the extremes in the discount range in controlled proportions to achieve Micronaire of 3.8 to 4.2, thereby saving the most money.

The drawing frame blends were more difficult to supervise. Since the results show that these blends were no better than weigh pan blends, the recommendation is to use the latter.

Finally, mills following procedures comparable to this study can realize a substantial savings in raw material costs. The research was continued using Grade Combination 2, 1-inch staple, and a weigh pan blend of the extra high-extra low Micronaire range with a controlled average Micronaire of 3.8 to 4.0 and carded at 27 pounds per hour. The properties of the fabrics woven from these yarns are discussed in a separate report.

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MICRONAIRE BLEND	BLEND METHOD	GRADE 1 15/16" Bales	GRADE 1 1" Bales
MH - ML MH - ML	HOPPER DRAWING	8	8
EH - EL EH - EL	HOPPER DRAWING	8	8
HML	HOPPER	4	4
CONTROL	HOPPER	4	4
	BALES	24	24

Figure 1 - METHOD OF BLENDING.

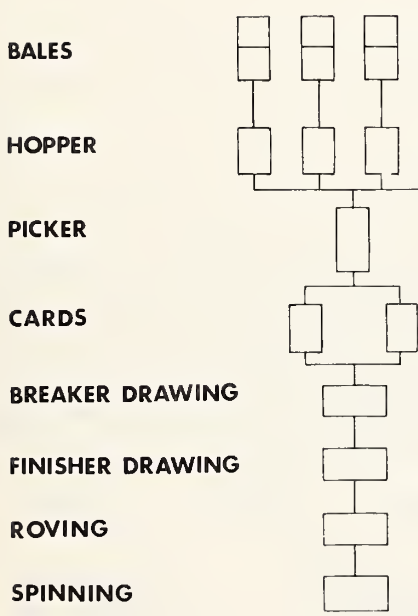


Figure 2 - FLOW CHART OF HOPPER BLENDS.

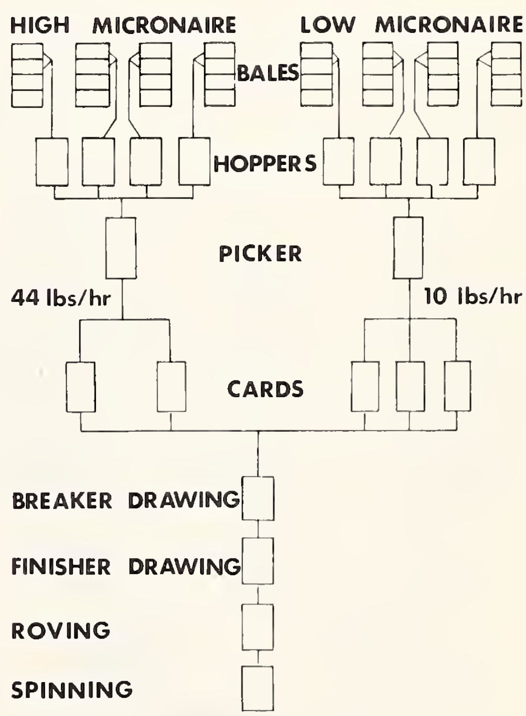
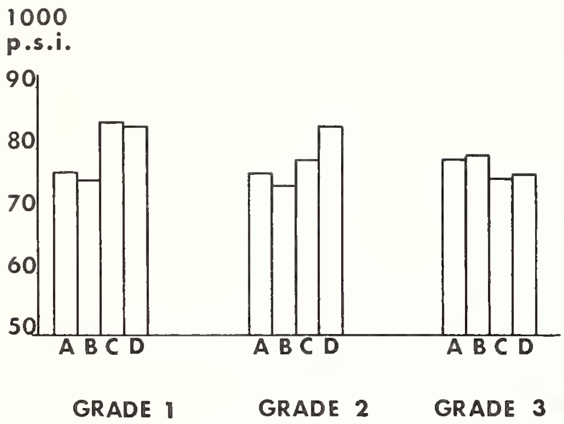
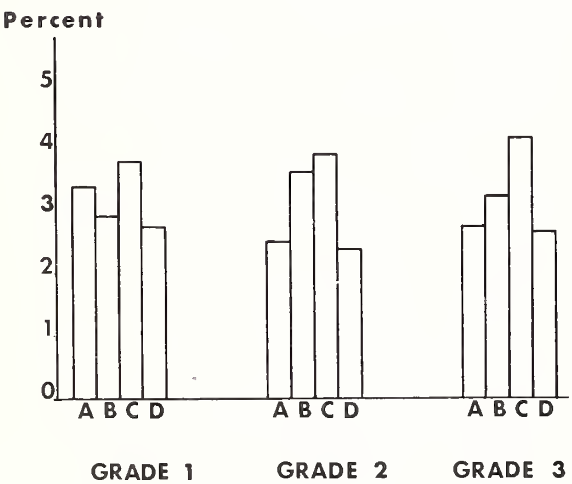


Figure 3 - FLOW CHART OF DRAWING FRAME BLENDS.



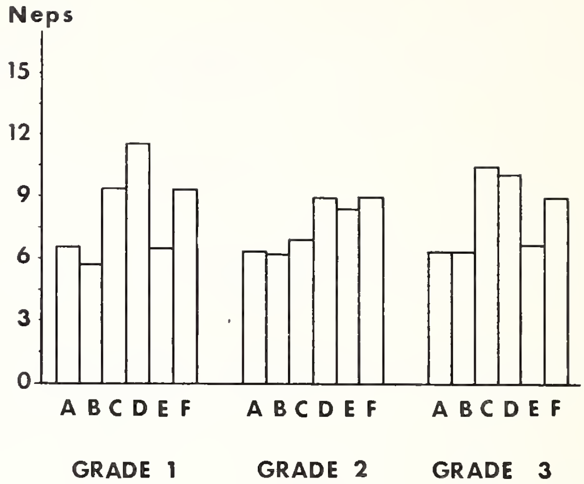
A-CONTROL
B-HML
C-EHEL
D-MHML

Figure 4 PRESSLY - - "O" GAGE, 1-INCH COTTON



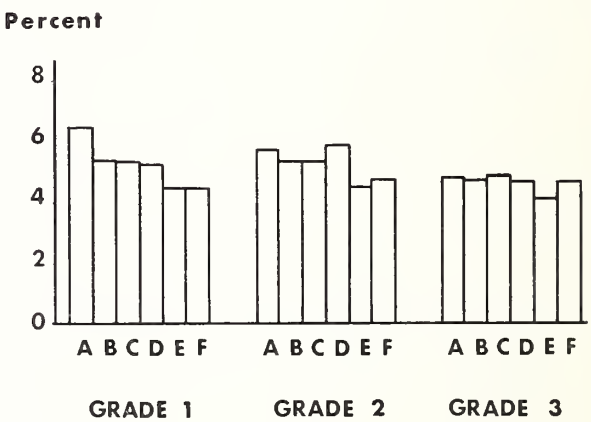
A-CONTROL
B-HML
C-EHEL
D-MHML

Figure 5 NONLINT PERCENT, 1-INCH COTTON.



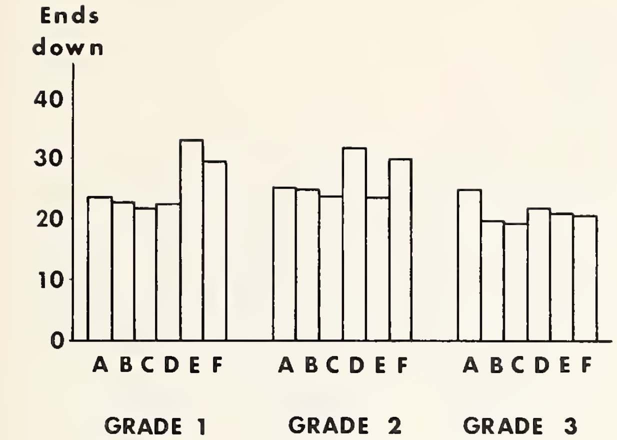
A-CONTROL
B-HML
C-EHEL - HB
D-EHEL - DB
E-MHML-HB
F-MHML-DB

Figure 6 CARD NEPS PER 100 SQUARE INCHES, 1-INCH COTTON.



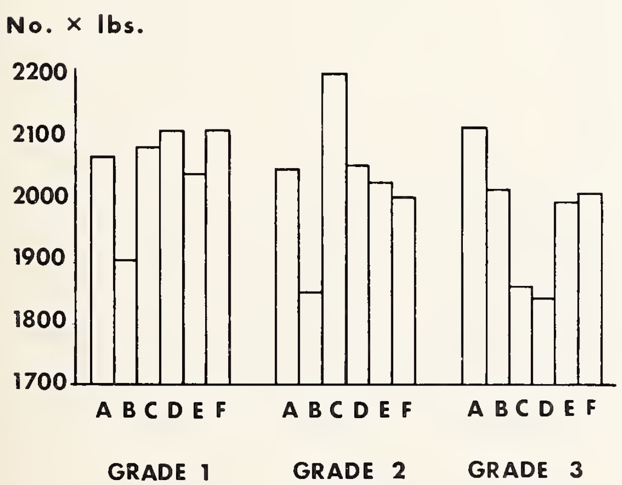
A-CONTROL
B-HML
C-EHEL - HB
D-EHEL - DB
E-MHML-HB
F-MHML-DB

Figure 7 ADJUSTED PICKER AND CARD WASTE PERCENT, 1-INCH COTTON.



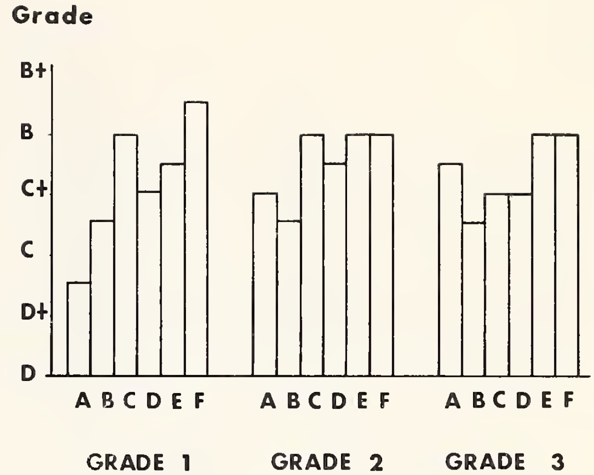
A-CONTROL
B-HML
C-EHEL - HB
D-EHEL - DB
E-MHML-HB
F-MHML-DB

Figure 8 ENDS DOWN PER 1000 SPINDLE HOURS, 1-INCH COTTON.



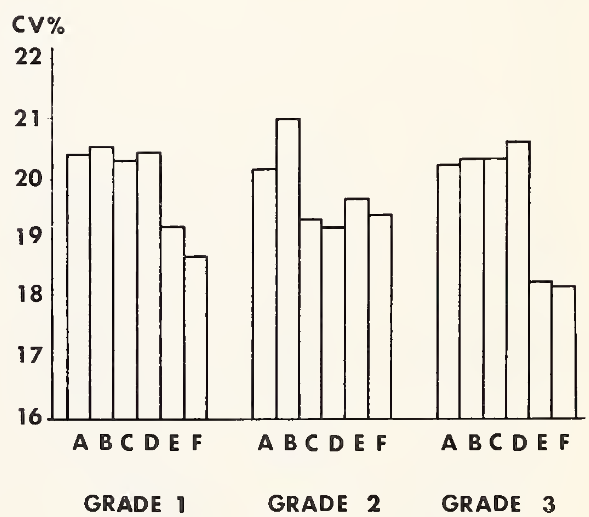
A-CONTROL
B-HML
C-EHEL - HB
D-EHEL - DB
E-MHML-HB
F-MHML-DB

Figure 9 BREAK-FACTOR, 1-INCH COTTON.



A-CONTROL
B-HML
C-EHEL - HB
D-EHEL - DB
E-MHML-HB
F-MHML-DB

Figure 10 YARN APPEARANCE GRADE, 1-INCH COTTON.



A-CONTROL
B-HML
C-EHEL - HB
D-EHEL - DB
E-MHML-HB
F-MHML-DB

Figure 11 USTER CV PERCENT, 1-INCH COTTON.

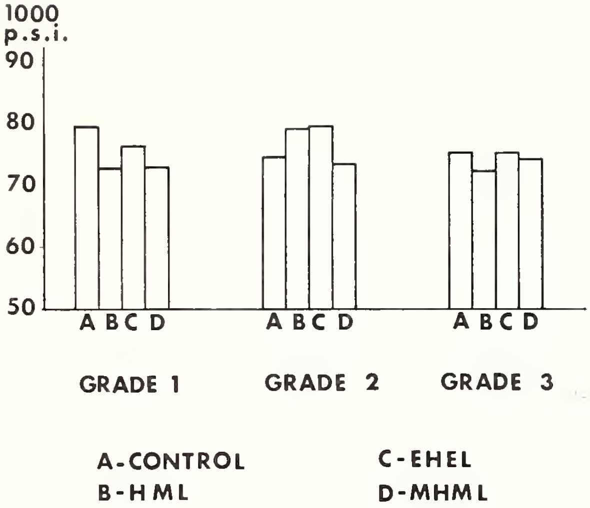


Figure 12 PRESSLY -- "O" GAGE, 15/16-INCH COTTON.

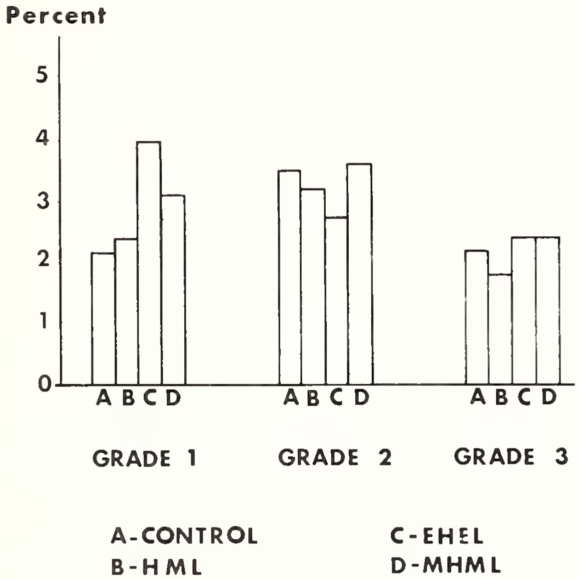


Figure 13 NONLINT PERCENT, 15/16-INCH COTTON.

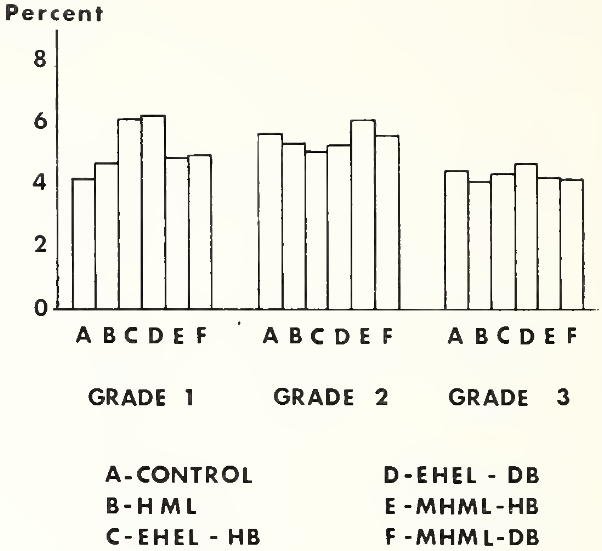


Figure 14 ADJUSTED PICKER AND CARD WASTE PERCENT, 15/16-INCH COTTON.

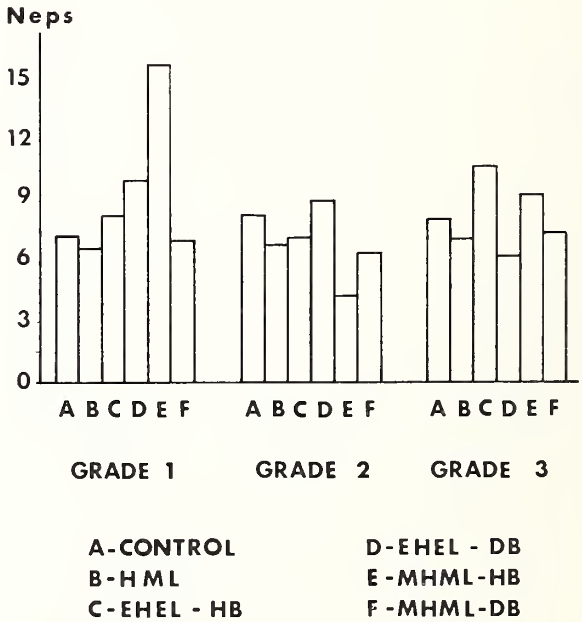


Figure 15 CARD NEPS PER 100 SQUARE INCHES, 15/16-INCH COTTON.

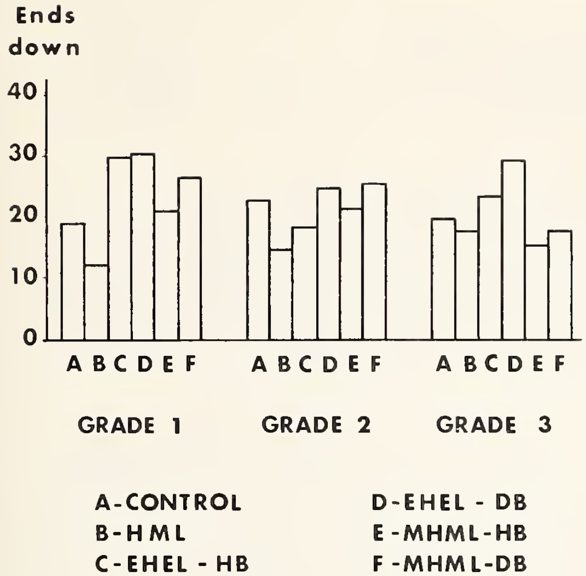


Figure 16 ENDS DOWN PER 1000 SPINDLE HOURS, 15/16-INCH COTTON.

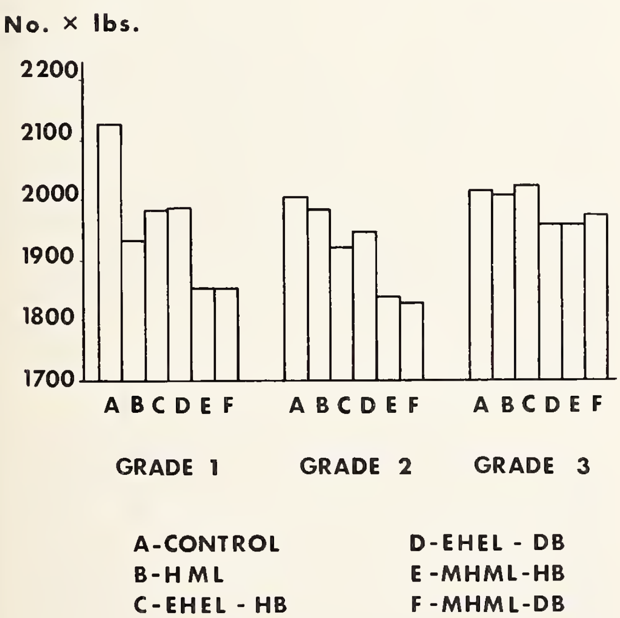


Figure 17 BREAK-FACTOR, 15/16-INCH COTTON.

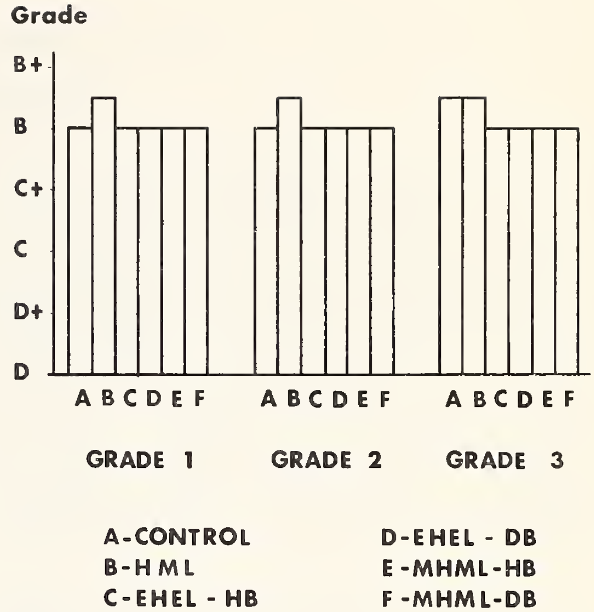


Figure 18 YARN APPEARANCE GRADE, 15/16-INCH COTTON.

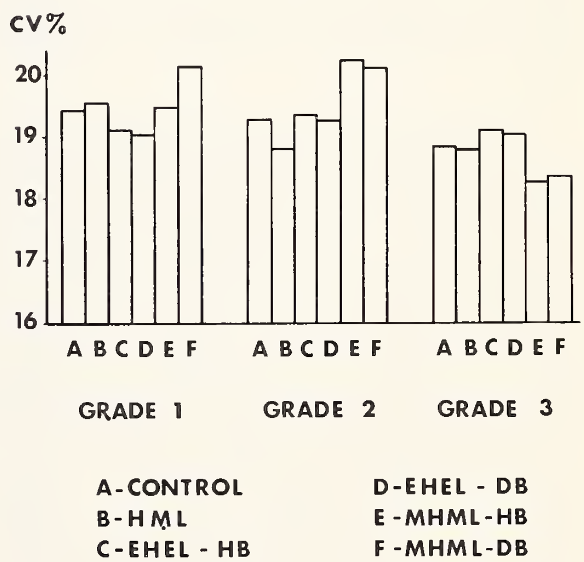


Figure 19 USTER CV PERCENT, 15/16-INCH COTTON.

UTILIZATION OF SHORT STAPLE DISCOUNT COTTON IN FABRICS FOR SPECIFIC END USES [1]

by

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Two principle methods of textile process research are used where fibers other than those normally used are to be considered. One method, often chosen by textile mills, involves the determination of the best product quality that can be achieved by reoptimizing the process in terms of equipment choice, equipment running conditions, and economics. The second method, common to many laboratories, sets the processing schedule to magnify weaknesses in the independent variables. Each method is suitable for different objectives.

When the objective is to determine if product quality standards can be met by using a reoptimized process, that is, using the first method, results frequently indicate that the new process details certainly can be used at least in specific instances, and that benefits can result. This work had that goal. While it is not realistic to expect that a mill would follow the exact process details developed, we suggest that there are guidelines offering economic potential. In this period of cotton shortage, available stocks can be profitably utilized in blend combinations normally considered extreme.

Blending extreme grades and finenesses of cotton is not new. In the eighteenth century, British textile mills were receiving cotton from all over the cotton-growing world and making good use of it in combinations that present technology would label as absurd. Baines (4) reported that in 1835 cotton was separated into long staple, short staple, and yellow classes, the separation by color being taken much less seriously. Baines stated, "Except the better qualities of Sea Islands, there is no sort of cotton which is now confined in its use to any peculiar or exclusive purpose. By mixing different sorts together, and by careful management in preparing the mixture for the spinning, the manufacturers can now make a substitute for almost any particular kind of cotton, except the very best.

"A few words must be said as to the distinguishing qualities of cotton-wool in the estimation of the manufacturer. The quality depends on the length, strength, and fineness of the fibre, or, as it is called in the trade, the staple: but these, which are essential attributes of quality, are modified by the cleanliness and the colour."

Considering the technological advances in processing over 150 years, particularly in blending and chemical processing, one must question the justification for the recognition of 3,724 types of cotton [2] by the cotton textile industry. It must be pointed out that with good blending control, mills located in countries not producing their own cotton frequently use mixes containing spreads of 1/8-inch in staple and 30,000 p.s.i. in strength. Furthermore, cotton/polyester blends have a 1/2-inch staple spread.

The work reported here will demonstrate that extremes in grade, fineness, and color can be blended by using techniques of cotton/polyester processing, which have become commonplace. In support of this, data are presented on the properties of yarns and greige and finished fabrics with a considerable variety of chemical and mechanical treatments. It is of signal importance that these fabrics could be dyed in 500-yard lengths to solid shades of acceptable levelness, since it has become almost axiomatic that blends of cotton differing widely in maturity cause major difficulties in dyeing in yarn or piece form to solid shades.

MATERIALS AND METHODS

Twenty-eight bales of unknown variety cotton divided into two levels of fineness and three levels of grade were used to produce nine fabrics, with three from each of the categories: Industrial fabrics, household fabrics, and apparel fabrics. The number of bales and the average fiber properties of these cottons are shown in Table 1. The mechanical processing variables and

[1] A report of work done under contract with U.S. Department of Agriculture and authorized by the Research and Marketing Act. The contract is being supervised by the Southern Marketing and Nutrition Research Division, Agricultural Research Service, U.S. Department of Agriculture.

[2] Based on the schedule of minimum loan rates, Lubbock, Texas, 1971.

Table 1. — Fiber properties of cottons selected

Function	Number of bales	Micronaire Reading	Nonlint content Percent	Color grade	Fiber Length: 2.5 percent span length Inches	Fiber Length: UR Percent	1000 p.s.i.	1/8 inch gage length Gf/tex	Elongation Percent
Mean	7	5.62	2.46	SLM	1.006	44.8	86.88	22.47	6.14
C.V. %		4.05	24.86		1.40	1.92	1.99	1.98	11.03
Mean	7	5.55	2.38	SLM	1.000	44.6	87.16	21.98	6.21
C.V. %		5.43	20.50		1.00	1.63	2.46	3.25	6.52
Mean	7	2.69	8.79	LM Sp.	1.028	41.9	77.18	21.53	7.79
C.V. %		5.84	18.57		2.37	2.29	2.96	7.08	1.60
Mean	7	2.87	7.36	LM Lt. Sp.	1.032	42.9	81.15	23.51	7.56
C.V. %		3.95	10.35		2.16	1.39	1.94	8.23	1.90
G. Mean 1/		3.916	4.83		1.010	43.9	83.74	22.36	6.80

1/ Weighted for blended proportions to result in a 3.8 to 4.0 Micronaire at finisher drawing.

fabric construction specifications are exhibited in Table 2. Fabric construction was based on yarn numbers commercially spun from cotton with a 1-inch staple.

Fiber, yarn, and fabric measurements were made according to ASTM methods. The cotton was weigh-pan blended to obtain a Micronaire of 3.8 to 4.2 at the second drawing process. Carding was done on cards equipped with metallic card clothing and crush rolls. Ends down counts were made on both warp and filling during the spinning of the quantity of yarn required to produce approximately 2,000 yards of each of the nine fabrics.

Finishing procedures employed are summarized in Table 3.

Table 2. — Mechanical processing variables and fabric construction specifications

1.	Picker Lap Wt. (oz./yd.)		15
2.	Carding:	Production rate (lb./hr.)	27
		Sliver wt. (gr./yd.)	60
3.	Drawing:	Delivery speed (ft./min.)	300 and 825
		Doubling	64
4.	Roving size (hank)		0.50, 0.80, and 1.00
5.	Fabrics:		

		Width (inches)	Construction	Weight (oz./yd.^{2})
a.	3/2 R. H. Twill (Denim)	48	88 X 48	7.5
b.	Bedford Cord	48	56 X 50	6.0
c.	Bark Cloth	36	88 X 48	6.8
d.	2/1 L. H. Twill (Pocket Drill)	37	72 X 44	6.2
e.	Sheeting	39	48 X 48	5.5
f.	Shoe Duck	37	50 X 36	7.8
g.	2/2 R. H. Twill (Canton Flannel)	37	64 X 44	7.8
h.	Huck toweling	18	84 X 42	5.9
i.	Terry toweling	25	65 X 36	11.5

6. Spinning*:

		Warp	Filling
a-e.	Yarn number	14/1	14/1
	T. M.	4.25	3.50
	Spindle speed (r.p.m.)	9500	9000
f.	Yarn number	16/2	18/2
	T. M.	4.25	4.00
	Spindle speed (r.p.m.)	9,600	10,500
g.	Yarn number	17/1	6.80/1
	T. M.	4.25	3.50
	Spindle speed (r.p.m.)	10,500	5,000
h.	Yarn number	17/1	15/1
	T. M.	4.25	3.50
	Spindle speed (r.p.m.)	10,500	9,000
i.	Yarn number	24/2 (G)//15/1(P)	12/1
	T. M.	4.50 (G)//4.25(P)	3.50
	Spindle speed (r.p.m.)	11,000 (G)//9,000(P)	8,000

*All yarns spun with 2-inch diameter rings.

Table 3. — Summary of finishing 1/

3/2 Twill (Denim)	Bedford Cord	Bark Cloth
Brushing and singeing	Singeing	Desizing
Desizing	Desizing	Caustic steaming
Caustic steaming	Caustic Steaming	Bleaching
Bleaching	Bleaching	Dyeing
Mercerizing	Mercerizing	Stiffening
Dyeing	Dyeing	Latex Backing 3/
Durable press sensitizing	Durable press sensitizing	Soil/oil repellent finishing
Sanforizing 2/	Sanforizing 2/	
Terry Toweling	**Huck Toweling**	**2/2 Twill (Canton Flannel)**
Desizing	Desizing	Napping 4/
Caustic steaming	Caustic steaming	
Bleaching	Bleaching	
Dyeing	Optical whitening	
Rewetting/softening finishing		
2/1 Twill (Pocket Drill)	**Shoe Duck and Sheeting**	
Sanforizing 5/	No finishing required	

1/ Detailed information available from the authors, or the sponsoring agency. This summarizes 22 pages of typewritten process sequence charts.

2/ At Mission Valley Mills, Inc., New Braunfels, Texas.

3/ At Sanford Finishing Corp., Sanford, N.C.

4/ At Houston Textile Co., Houston, Texas.

5/ At Brentex Mills, Inc., Brenham, Texas.

ANALYSIS OF DATA

Figure 1 shows the ends down for both warp and filling yarns, while Figure 2 shows the skein strength (break-factor) of all yarns. Table 4 contains the yarn grades, and Figure 3 presents the yarn nonuniformity.

All yarn properties were well within acceptable limits. The 14's yarn (3.50 T.M.) had a relatively high end breakage. However, even with a level of almost two times as high as the other yarns, the breakage was within commercially acceptable limits. The 24's yarn is, perhaps, the limit for 1-inch staple with the high Micronaire fiber, is acceptable in a ply yarn for a terry fabric.

All fabric tests were made on greige and finished fabrics. It should be noted that in the case of the 3/2 Twill and Bedford Cord, the finished fabric tests were made on sensitized but uncured fabrics.

Figures 4 and 5 show the fabric grab strength in both warp and filling directions. The finishing treatments did not have a pronounced effect on the fabric strengths. The losses were well within the expected levels. Although no control fabrics were produced for comparison, discussions with mill supervisors familiar with these fabrics provided confidence in this analysis.

Flex abrasion is shown in Figures 6 and 7. The finishing processes had a quite significant effect on these fabrics. At this time, it is not possible to attribute this to the fiber properties. Those fabrics that have been singled out for discussion with commercial finishers do not have

Table 4. — Yarn grades

Yarn Number	Twist Multiplier	Warp	Filling
6.8/1	3.50	—	C+
12.0/1	3.50	—	C
14.0/1	4.25	C	—
14.0/1	3.50	—	C
15.0/1	4.25	C	—
15.0/1	3.50	—	C
16.0/1	4.25	C	—
17.0/1	4.25	C	—
18.0/1	4.00	C	—
24.0/1	4.50	C	—

a greater than expected loss in abrasion resistance. Tests did indicate that with the addition of fabric softening agents, flex abrasion could be dramatically improved. Tear strength results are shown in Figures 8 and 9. The comments on the flex abrasion results apply equally here.

COMMENTS ON DYEING

A generalization has arisen over the years that blends of cottons differing widely in maturity will cause major difficulties in dyeing to level shades in yarn or piece form. This view has continued to the present day. In the late 1940's the Goldthwait-Smith-Barnett (GSB) differential dyeing technique (1,5) was developed to aid in identifying cotton fiber maturity differences and thereby to allow selecting cottons for even running and dyeing, for minimizing dyeing defects due to excessive neps, and for avoiding such troubles as may arise from irregular blending of fibers of different dyeing characteristics. The GSB technique has become the basis for an ASTM Standard Test Method (3).

Unlevel dyeings associated with maturity differences may be related to two different fiber distribution nonuniformities. First, neps of immature cotton on a fabric field of an otherwise uniformly distributed blend of high and low Micronaire cotton in the yarns can cause an obvious specky differential dyeing, the neps usually being dyed to a lesser depth of the same hue. Second, a nonuniformly distributed blend of high and low maturity cotton in yarn, excluding neps, can cause differential dyeing along discrete yarn lines, or segments thereof. Even in a nepless and uniformly distributed blend of high and low Micronaire cotton in yarns, a skittery, frosty dye unlevelness could, in principle, result.

Difficulties in dyeing blends of cottons differing widely in maturity, and the associated GSB test method, were more real in the 1940s than today. These difficulties and the test method are based on the direct dye class which was very important in the 1940s and earlier. However, direct dyes have largely been superseded by dyes giving more durable and otherwise attractive dyeings. Limitations on cotton fiber blends caused by dyeing difficulties in an earlier era of less well-developed dyeing technology must be reassessed in terms of changes in that technology. Very significant changes in dyeing of cotton fabrics have, in fact, occurred, since the late 1940s. The advent of nonexhaustion dyeing processes, dyes which are insensitive to cotton maturity differences, and treatments before or after dyeing are the most important in regard to the situation at hand.

It is significant that it was possible to produce 500 yard lengths of the 3/2 Twill, the Bedford Cord, the Bark Cloth, and the Terry Toweling dyed to uniform shades acceptable in terms of end to end and side to center levelness, specky unlevelness, and unlevelness along discrete yarn lines or segments of yarn.

Although it is outside the scope of this article to document the procedure and its development, a test method was developed which should allow prediction of success in dyeing, with reactive and sulfur dyes, fabrics from blends of low and high maturity cotton. This test is performed on sets of staple samples from the bales.

Blending efficiency was monitored at several points by Micronaire measurements; it was also checked by dyeing tests that are far more sensitive. The GSB test was supplemented with a newly developed test, the TRC test, for this work. Although the GSB test is useful in monitoring blending efficiency, the TRC test was less erratic, and has other advantages, vis-a-vis the GSB test, among which are (1) more rational instrumental measurement of color differences, (2) less confusing visual evaluation of color differences, and (3) a simpler dyeing procedure, that is, the boiling rinse is omitted. Both the GSB and TRC tests indicated that blending in this project could not be described as having produced a perfectly uniform distribution of high and low Micronaire cotton in the yarn. However, the blend was good enough to allow production of the 500 yard level dyeings mentioned above. This is taken as another example of the often observed situation where test methods do not allow acceptable materials to pass.

SUMMARY

A three-way blend of color and a two-way blend of Micronaire fineness cottons was processed to produce nine fabrics on a semi-commercial scale. Practical processing methods were used which, in instances, incorporated known features for improved product quality. Laboratory techniques based on dye uptake indicate that the blend of the Micronaire-differing cottons was not perfectly uniform. Traditional test methods for selecting cottons for smoothly running mechanical and chemical processing are not necessarily representative of the current state of the technology. Uniform dyings, both dark and light, can be achieved with extreme blends of short staple cottons in a full-scale production system with the usual degree of quality control.

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(5) Goldthwait, Charles F., Smith, Herbert O., and Barnett, Mary P.
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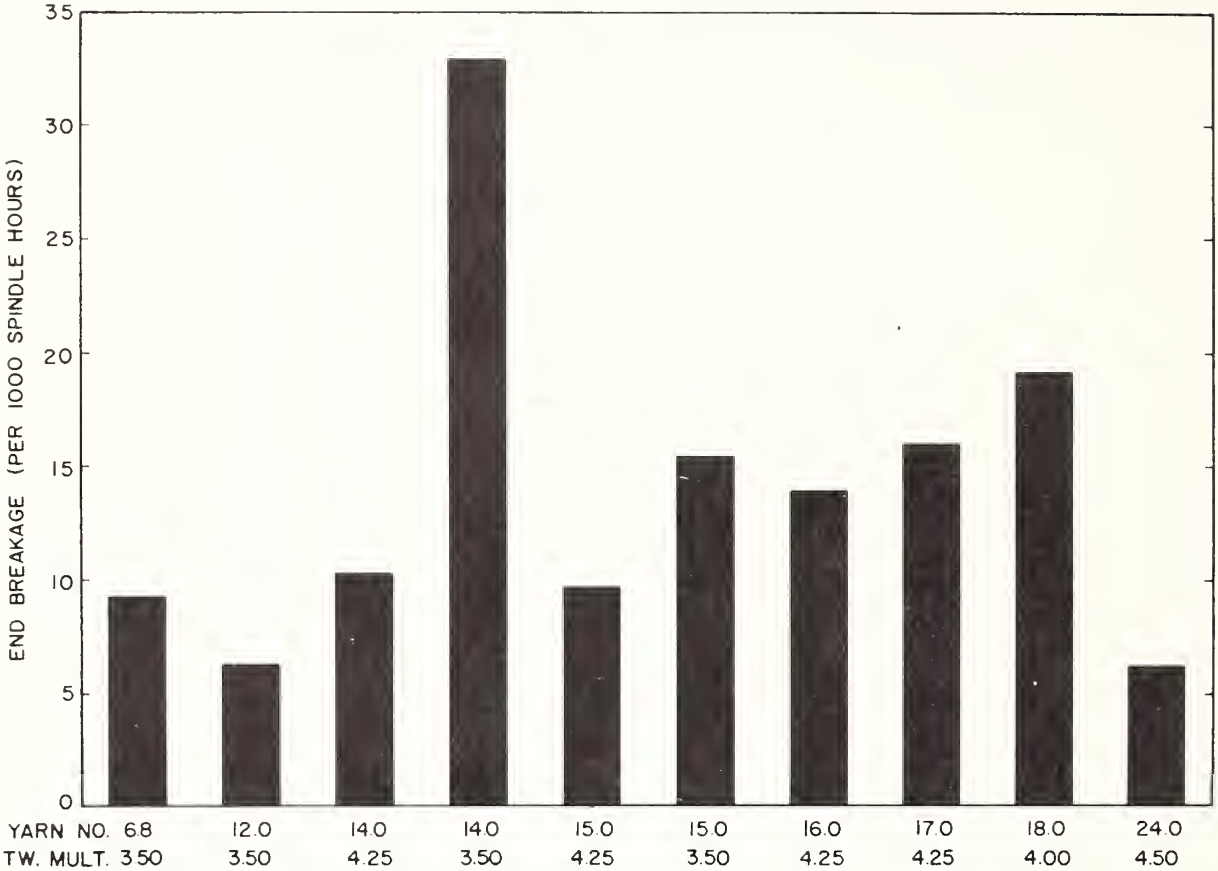

Figure 1 - End breakage for both warp and filling yarns.

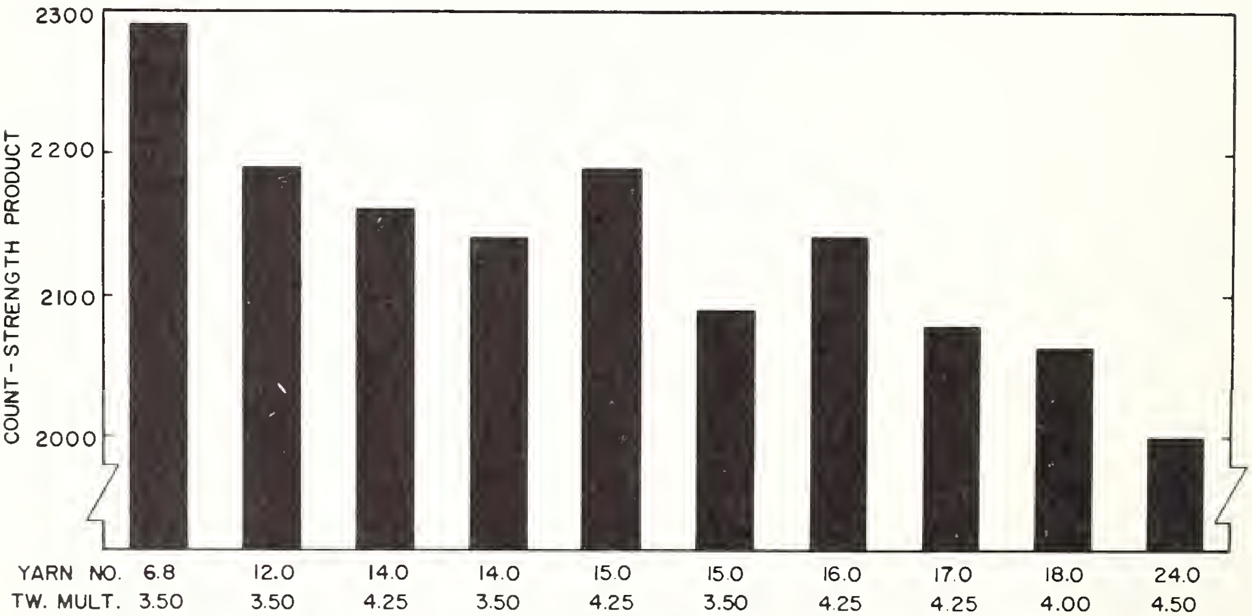

Figure 2 - Skein yarn strengths for both warp and filling yarns

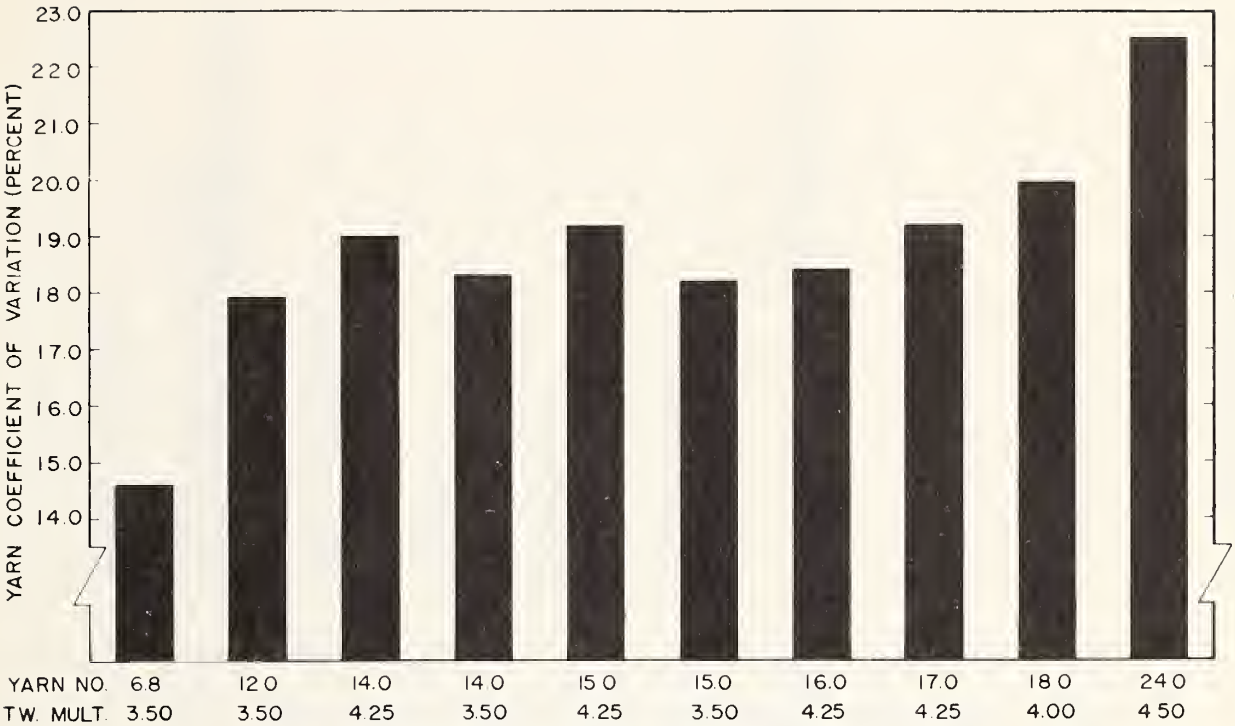

Figure 3 - Yarn nonuniformity (Uster).

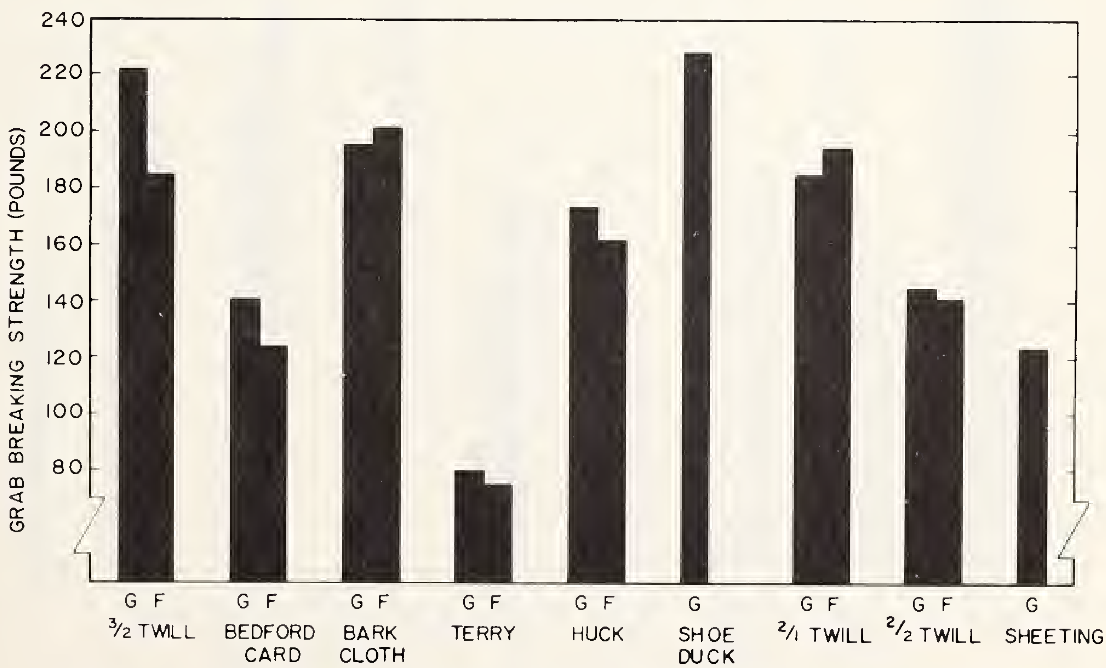

Figure 4 - Grab breaking strengths of greige and finished fabrics (warp direction).

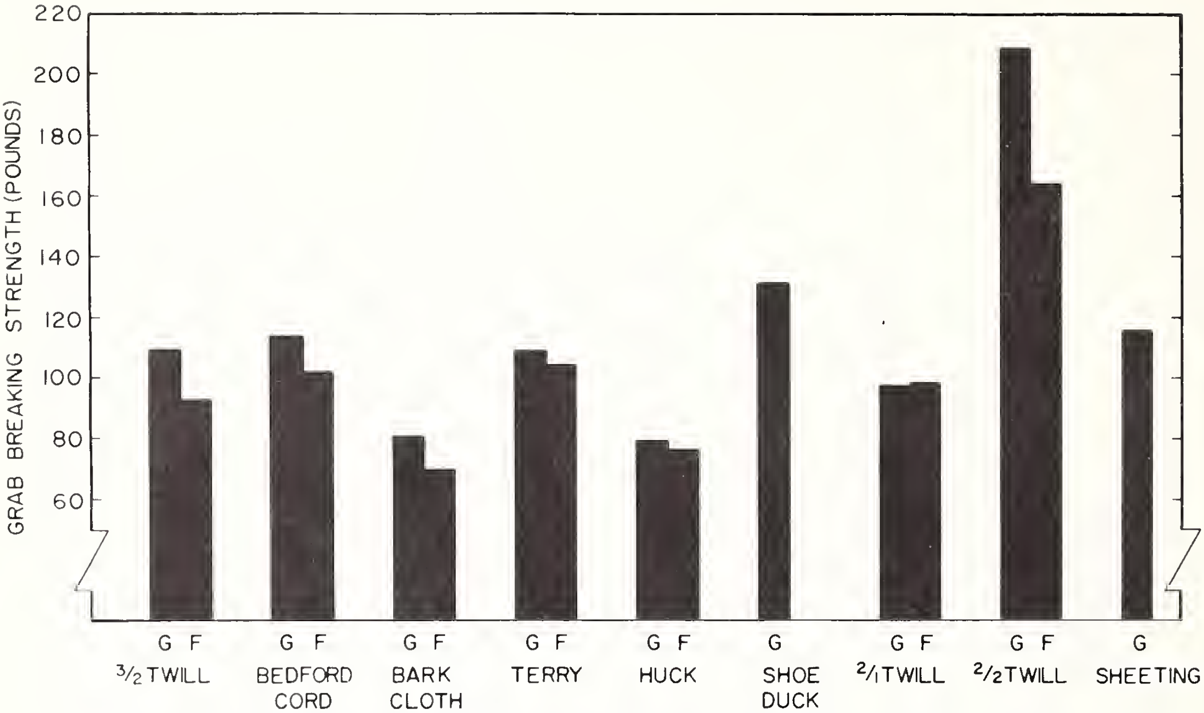

Figure 5 - Grab breaking strengths of greige and finished fabrics (filling direction).

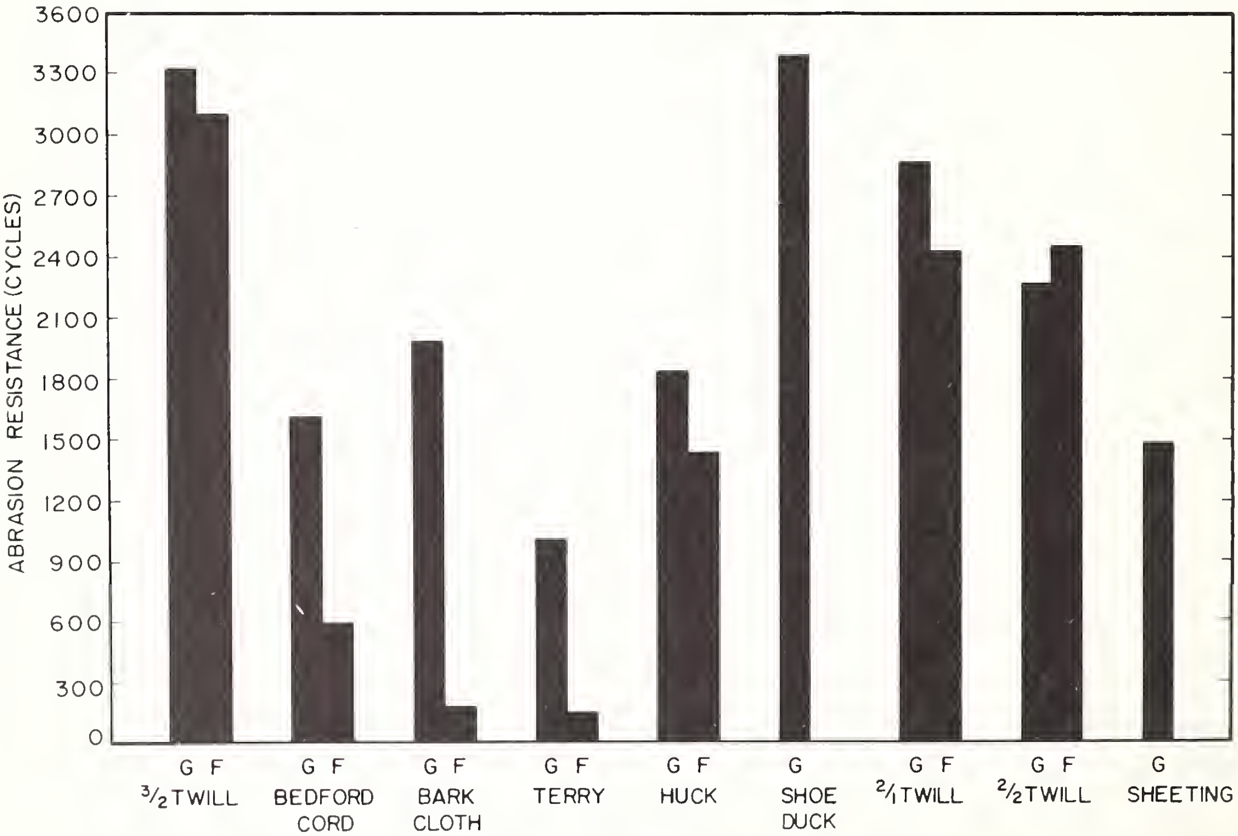

Figure 6 - Flex abrasion resistance of greige and finished fabrics (warp direction).

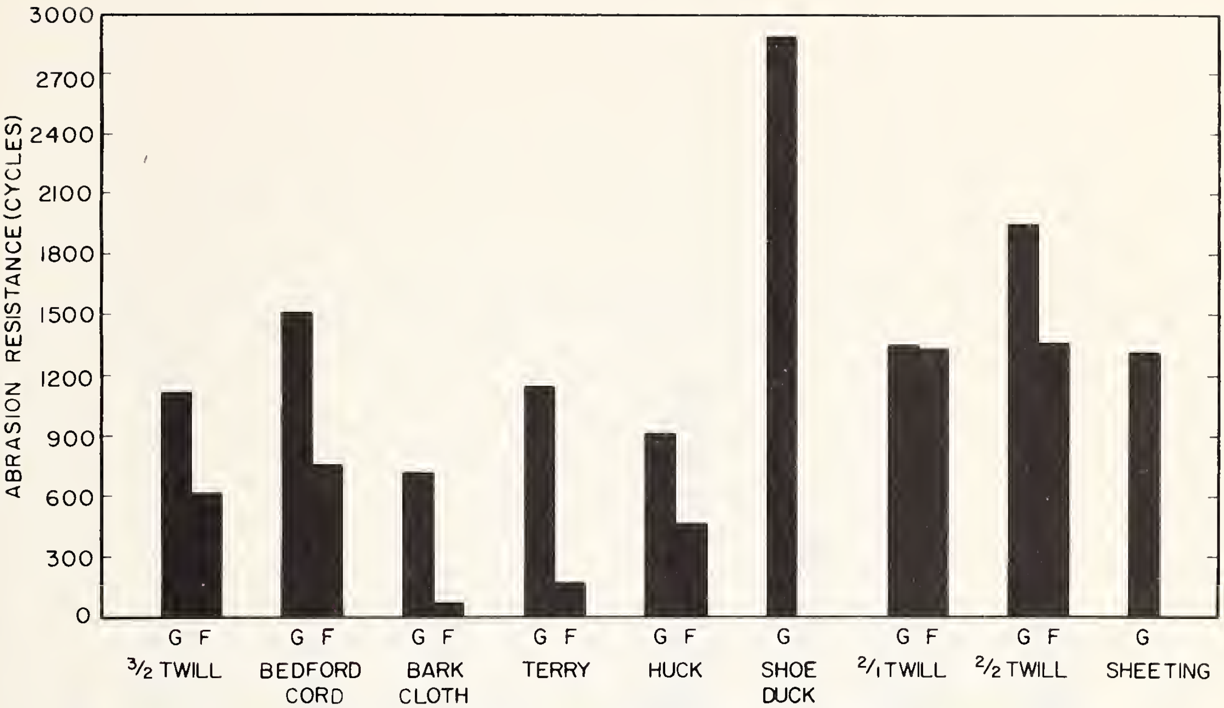

Figure 7 - Flex abrasion resistance of greige and finished fabrics (filling direction).

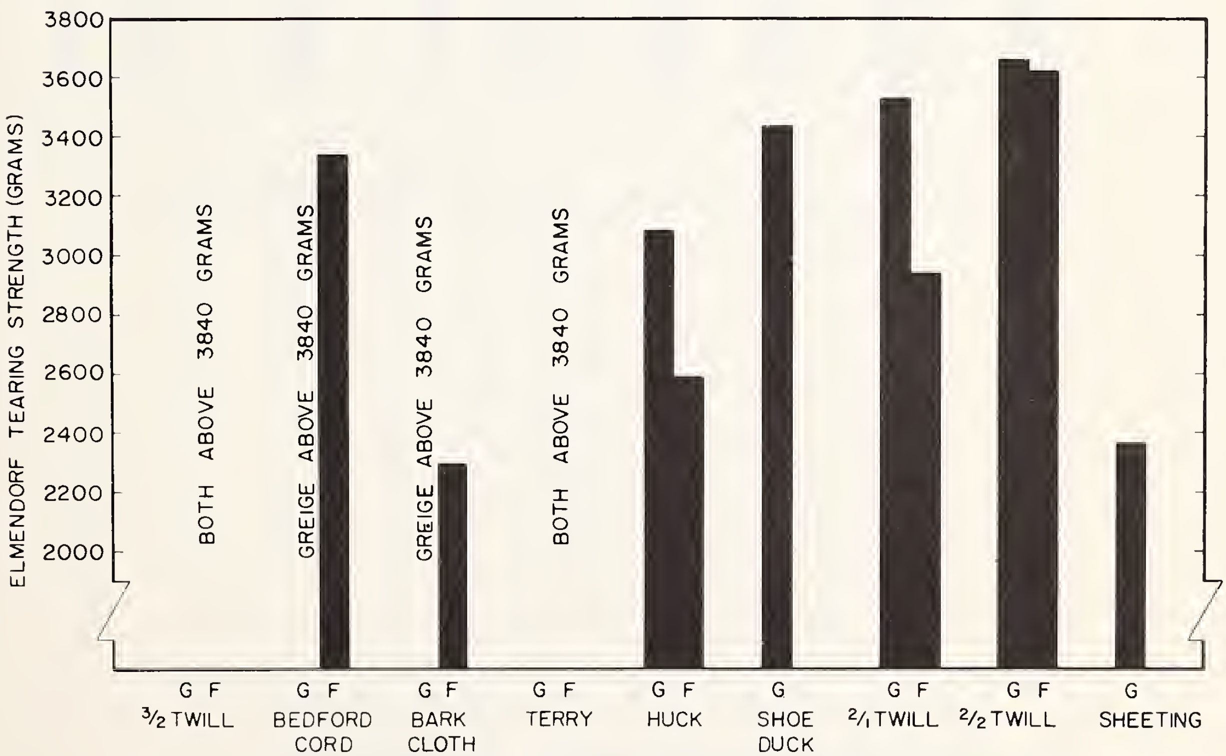

Figure 8 - Tearing strength of greige and finished fabrics (warp direction).

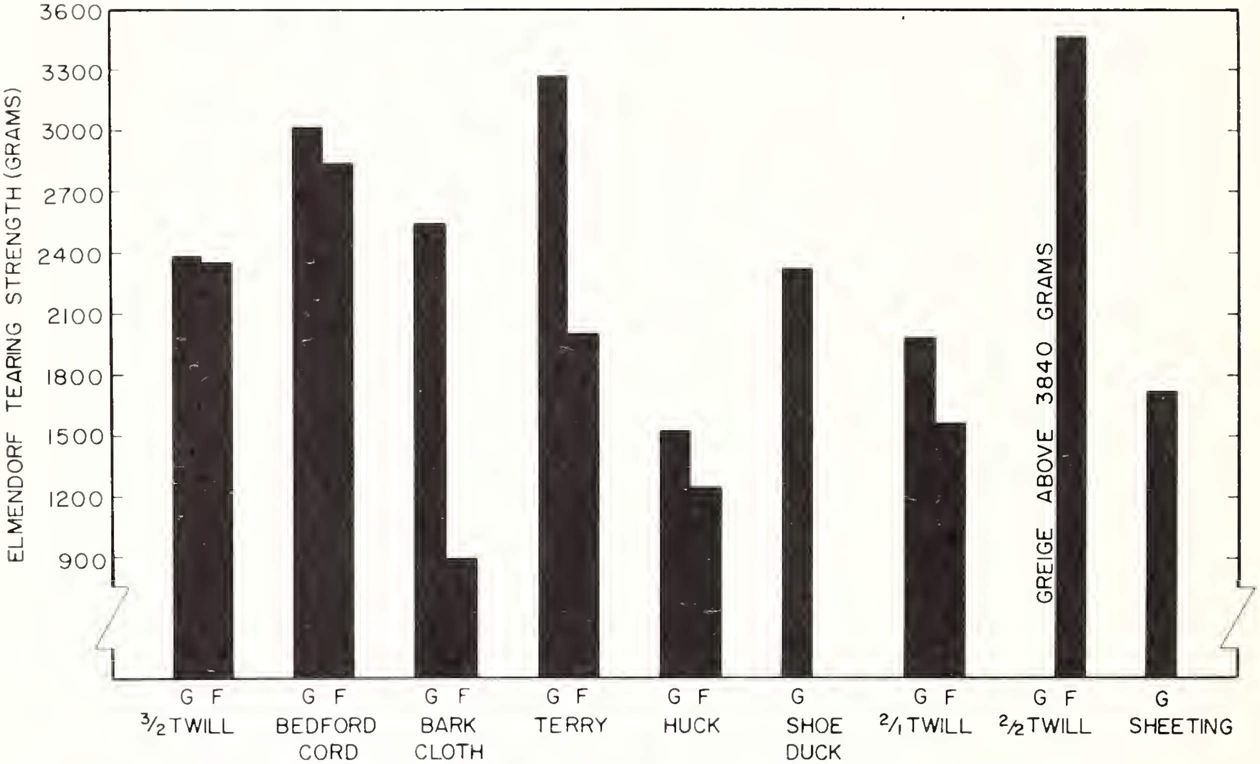

Figure 9 - Tearing strength of greige and finished fabrics (filling direction).